VIII INTERNATIONAL SYMPOSIUM ON AGRICULTURAL SCIENCES

16-18 May, 2019

Trebinje, Bosnia and Herzegovina

AGRORES

2019

BOOK OF PROCEEDINGS

Banja Luka

2019

VIII INTERNATIONAL SYMPOSIUM ON AGRICULTURAL SCIENCES

16-18 May, 2019
Trebinje
Bosnia and Herzegovina

Book of proceedings

VIII International Symposium on Agricultural Sciences "AgroReS 2019"

16-18 May, 2019

Trebinje, Bosnia and Herzegovina

Book of proceedings

Publisher

University of Banja Luka
Faculty of Agriculture
University City
Bulevar vojvode Petra Bojovića 1A
78000 Banja Luka, The Republic of Srpska, B&H

Editor in Chief

Željko Vaško

Technical Editor

Biljana Rogić

Language

English

Book of proceedings available in electronical format on the web page www.agro.unibl.org
http://agro.unibl.org/wp-content/uploads/2019/07/Book-of-Proceedings-AgroReS-2019.pdf

CIP - Каталогизација у публикацији

Народна и универзитетска библиотека

Републике Српске, Бања Лука

631(082)

INTERNATIONAL Symposium on Agricultural Sciences (8 ; Trebinje ; 2019)

Book of Proceedings [Elektronski izvor] / 8th International Symposium on Agricultural Sciences "AgroReS 2019", 16-18 May, 2019, Trebinje, Bosnia and Herzegovina ; [organizer University of Banjaluka, Faculty of Agriculture ; editor in chief Željko Vaško]. - Banja Luka : Faculty of Agriculture = Poljoprivredni fakultet, 2019. - 241 str. : ilustr. ; 30 cm

Način pristupa (URL): http://agro.unibl.org/wp-content/uploads/2019/07/Book-of-Proceedings-AgroReS-2019.pdf. - Na nasl. str.: AgroRes 2019. - Bibliografija uz svaki rad.

ISBN 978-99938-93-56-1

COBISS.RS-ID 8264472

ORGANIZERS

Faculty of Agriculture
University of Banja Luka

in cooperation with

Biotechnical Faculty
University of Ljubljana

Faculty of Agriculture
University of Novi Sad

Faculty of AgriSciences
Mendel University in Brno

Mediterranean Agronomic
Institute of Bari

Genetic Resources Institute
University of Banja Luka

Biotechnical Faculty
University of Montenegro

RebResNet Scientific Network

The Chamber of Agriculturalral Engineers of the Republic of Srpska

SUPPORTED BY

Ministry for Scientific and Technological Development, Higher Education and Information Society of the Republic of Srpska

and

Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska

ORGANIZING COMMITTEE

President
Željko Vaško, PhD

Secretary
Biljana Rogić, PhD
Siniša Mitrić, PhD

Members

Miljan Cvetković, PhD; Nebojša Savić, PhD; Đorđe Savić, PhD; Zoran Maličević, PhD; Dragan Brković, ma; Tanja Krmpot, ma; Slobodan Stojnić, ma; Milan Šipka, B.Ag.; Zdravko Marković, B.Ag.; Mladen Babić, B.Ag.; Danijela Kuruzović.

SCIENTIFIC COMMITTEE

Novo Pržulj, president, *BiH*; Geza Bujdoso, *Hungary*; Adrian Asanica, *Romania*; Đorđe Moravčević, *Serbia*; Klime Beleski, *North Macedonia*; Edi Maletić, *Croatia*; Miljan Cvetković, *BiH*; Gregogi Lang, *USA*; Sezai Erkisli, *Turkey*; Desimir Knežević, *Serbia*; Snježana Hrnčić, *Montenegro*; Danijela Kondić, *BiH*; Duška Delić, *BiH*; Ilija Komljenović, *BiH*; Ivica Đalović, *Serbia*; Jelena Čukanović, *Serbia*; Siniša Mitrić, *BiH*; Jan Turan, *Serbia*; Daniel Falta, *Czech Republic*; Radko Rajmon, *Czech Republic*; Božo Važić, *BiH*; Milanka Drinić, *BiH*; Nebojša Savić, *BiH*; Stoja Jotanović, *BiH*; Goran Mirjanić, *BiH*; Biljana Rogić, *BiH*; Đorđe Savić, *BiH*; Vesna Gantner, *Croatia*; Andrei Jean-Vasile, *Romania*; Hrabrin Bašev, *Bulgaria*; Emil Erjavec, *Slovenia*; Nebojša Novković, *Serbia*; Zorica Vasiljević, *Serbia*; Aleksandra Martinovska, *North Macedonia*; Miomir Jovanović, *Montenegro*; Željko Vaško, *BiH*; Vesna Mrdalj, *BiH*; Stanislav Minta, *Poland*; Mladen Todorović, *Italy*; Hamid El Bilali, *Italy*; Vladimir Meglič, *Slovenia*; Gordana Đurić, *BiH*; Zlatan Kovačević, *BiH*; Mirjana Žabić, *BiH*; Mihajlo Marković, *BiH*, Nikola Mićić, *BiH*; Mihael Toman, *Slovenia*, Pandi Zdruli, *Italy*, Alban Ibraliu, *Albania*.

HONORARY COMMITTEE

1. Srđan Rajčević, MSc, Minister for Scientific and Technological Development, Higher Education and Information Society, the Republic of Srpska;
2. Boris Pašalić, PhD, Minister of Agriculture, Forestry and Water Management, the Republic of Srpska;
3. Mirko Ćurić, Mayor of Trebinje City;
4. Radoslav Gajanin, PhD, Rector of University of Banja Luka;
5. Zlatan Kovačević, PhD, Dean of Faculty of Agriculture, University of Banja Luka;
6. Emil Erjavec, PhD, Dean of Biotechnical Faculty, University of Ljubljana;
7. Nedeljko Tica, PhD, Dean of Faculty of Agriculture, University of Novi Sad;
8. Miomir Jovanović, PhD, Dean of Biotechnical Faculty, University of Podgorica;
9. Maurizio Raeli, PhD, Director of Mediterranean Agronomic Institute of Bari;
10. Pavel Ryant, PhD, Dean of Faculty of AgriSciences, Mendel University in Brno;
11. Gordana Đurić, PhD, Director of Genetic Resources Institute, University of Banja Luka;
12. Andrei Jean-Vasile, PhD, RebResNet scientific network, director/scientific coordinator;
13. Jasenko Nedinić, B.Ag., President of The Chamber of Agricultural Engineers of the Republic of Srpska.

TABLE OF CONTENTS

		Pages
	TABLE OF CONTENTS	6-8
	PREFACE	9
1.	Dragan Mandić, Novo Pržulj, Goran Đurašinović, Zoran Jovović VITEZ - NEW VARIETY OF WINTER MULTI-ROWED BARLEY	10-16
2.	Miloš Nožinić, Vesna Bojić, Nikola Kezić, Dragan Romčević, Nemanja Babić, Ivana Petrović RAPESEED OIL AS A BIODEGRADABLE LUBRICANT	17-25
3.	Dushko Nedelkovski, Klime Beleski, Goran Milanov, Viktor Gjamovski, Biljana Korunovska IMPROVING THE FRUIT QUALITY OF CRIMSON SEEDLESS (*Vitis vinifera* L.) USING VINE TRUNK GIRDLING AND GA3 AS AN AGROTECHNICAL TOOL	26-32
4.	Lovro Sinkovič, Mojca Škof, Kristina Ugrinović CULTIVATION PERIOD INFLUENCE OF DIFFERENT *Lactuca sativa* L. AND *Valeriana locusta* L. VARIETIES ON COLOUR PARAMETERS AND CHLOROPHYLL CONTENT	33-42
5.	Zorica Ranković-Vasić, Aleksandar Petrović, Nikolina Lisov, Saša Matijašević, Mirjam Vujadinović Mandić, Ana Vuković, Sara Muždalo, Dragan Nikolić PROPERTIES OF GRAPEVINE HYBRID '14362' OBTAINED FROM CROSSING COMBINATION RED TRAMINER × EARLY MUSCAT	43-49
6.	Nebojša Marković, Zoran Pržić VARIATION OF CLUSTERS AND BERRY STRUCTURAL INDICATORS OF CABERNET SAUVIGNON AND SAUVIGNON BLANC CV. (*Vitis vinifera* L.) UNDER THE INFLUENCE OF DEFOLIATION AND HARVEST TIME	50-59
7.	Dushko Nedelkovski, Klime Beleski, Venelin Roytchev, Goran Milanov POTENTIAL WINTER BUDS FERTILITY OF THE VINE VARIETY REBO	60-68
8.	Tijana Banjanin, Nikolina Lisov, Aleksandar Petrović, Zorica Ranković-Vasić, Milenko Blesić THE QUALITY OF GRAPE AND WINE OF MERLOT AND BLATINA VARIETIES IN THE AGROECOLOGICAL CONDITIONS OF THE TREBINJE VINEYARD	69-76
9.	Svjetlana Zeljković, Jelena Davidović Gidas, Vida Todorović, Milica Pašalić GERMINATION OF FLORAL SPECIES DEPENDING ON THE APPLIED BIOSTIMULANT	77-83

10. Đorđe Savić, Stoja Jotanović, Miroslav Borojević, Marinko Vekić, Zora Čolović-Šarić
CHEMICAL COMPOSITION OF MILK AS AN INDICATOR OF NUTRITIONAL STATE OF COWS 84-95

11. Nebojša Savić, Jerko Pavličević, Branko Glamuzina
THE EFFECTS OF RATION SIZE ON CONDITION FACTOR AND LENGTH-WEIGHT RELATIONSHIP OF THE BROWN TROUT (*Salmo trutta m. fario*) 96-103

12. Sara Popadić, Biljana Rogić, Božo Važić
THE AVERAGE RELATEDNESS COEFFICIENT IN LIPIZZAN HORSE FROM STATE-OWNED STUD VUČIJAK 104-112

13. Biljana Veljković, Ranko Koprivica, Dušan Radivojević, Zoran Mileusnić, Aleksandar Kuč
TECHNOLOGICAL PROCESS OF MILKING AND QUALITY OF MILK ON A COMMERCIAL FARM 113-121

14. Aleksandar Ostojić, Nebojša Savić, Jerko Pavličević, Željko Vaško
THE RELATIONSHIP BETWEEN IMPORT OF FEED FOR SALMONIDS AND EXPORT OF TROUT FROM BIH 122-130

15. Tamara Stojanović
COMPARATIVE FINANCIAL ANALYSIS OF CROP, LIVESTOCK AND MIXED AGRICULTURAL PRODUCERS' PROFITABILITY IN THE REPUBLIC OF SRPSKA 131-141

16. Nataša Tomić, Nemanja Jalić, Nikola Bulović
CONSUMER HABITS AND OPINIONS TOWARD ORGANIC PRODUCTS IN BANJA LUKA 142-151

17. Mirjana Bojčevski, Zorica Vasiljević, Vlado Kovačević
THE FADN AS AN ANALYTICAL TOOL IN EU AND SERBIA 152-163

18. Vesna Mrdalj, Nataša Tomić, Nemanja Jalić, Aleksandar Ostojić, Željko Vaško
COMPARATIVE ADVANTAGES AND INTRA-INDUSTRY TRADE FOR MEAT SECTOR IN BOSNIA AND HERZEGOVINA'S TRADE 164-174

19. Mihajlo Marković, Dijana Mihajlović, Svetlana Antić-Mladenović, Milan Šipka
LOCAL BACKGROUND VALUES OF THE LEAD IN THE SOILS OF THE BANJA LUKA AREA 175-184

20. Dragan Brenjo, Džemil Hajrić
EU POLICY ON FOOD QUALITY AND LEGISLATIVE FRAMEWORK IN BOSNIA AND HERZEGOVINA 185-195

21. Milan R. Milanović, Simo Stevanović
OPPORTUNITY COST OF SERBIAN AGRICULTURAL EXPORTS 196-207

21. Dragan Brenjo, Džemil Hajrić, Dragan Tomović
RESULTS OF MONITORING PESTICIDE RESIDUES IN AND ON FOOD OF PLANT AND ANIMAL ORIGIN ON THE MARKET OF BOSNIA AND HERZEGOVINA IN 2018 208-217

23. Božo Važić, Sara Popadić, Biljana Rogić, Vesna Gantner
GOAT FARMING: STAGNATION AND DEVELOPMENT ON THE TERRITORY OF BOSNIA AND HERZEGOVINA 218-228

24. Sreten Jelić, Tatjana Jovanović, Olga Gavrić
HOUSEHOLDS AS A MAIN FACTOR OF RURAL AND SUSTAINABLE DEVELOPMENT IN THE REPUBLIC OF SERBIA 229-240

PREFACE

The Book of Proceedings contains papers presented at VIII International Symposium on Agricultural Sciences "AgroReS 2019" held in Trebinje, Bosnia and Herzegovina, from 16 to 18 May, 2019.

In the Book of Proceedings are included only those papers for which their authors choose such a way of publishing.

All papers were subject to anonymous double reviews and the category of papers were determined by the editors based on the proposal of the reviewers.

Publisher and editors are not responsible for the content of papers and authors' opinions expressed in them. The text is not edited from the standpoint of English spelling and grammar, and the authors take the responsibility for the content of their papers in that regard.

The Proceedings are published only in electronic form and are available free of charge through the website of the Faculty of Agriculture, University of Banja Luka.

Editor in Chief
Željko Vaško

Technical Editor
Biljana Rogić

Original scientific paper

Vitez - new variety of winter multi-rowed barley

Dragan Mandić[1], Novo Pržulj[2], Goran Đurašinović[1], Zoran Jovović[3]

[1]Agricultural Institute of Republic of Srpska, Banja Luka, Bosnia and Herzegovina
[2]Faculty of Agriculture, University of Banja Luka and Faculty of Agriculture, University of East Sarajevo, Bosnia and Herzegovina
[3] Biotechnical Faculty, University of Podgorica, Montenegro

Corresponding author: Dragan Mandić, dmandic.pirs@gmail.com

Abstract

The high-yielding, medium-early winter variety of multi-rowed barley was created by the method of crossing genetically divergent parents, the varieties "Etincel and Krajišnik". The primary goal during the creation of this variety was selection for yield, while retaining other important agronomic characteristics at the level of standard, which was the variety of the Institute of Field and Vegetable Crops Novi Sad named "Rudnik". In this variety the successfully combined genes are responsible for a high fertility potential, good quality, very good resistance to lodging and excellent resistance to low temperatures. It was approved by the Serbian Variety Commission in 2018, following the two-year trial at seven locations, where it was determined that the variety is diverse, uniform and stable, with the genetic potential for yield over 10000 kg ha^{-1}, desirable shorter stem, and that on average for all locations and years it achieved significantly higher yield than the standard variety. According to the results of the two-year evaluation or testing of the Variety Commission, the variety Vitez achieved the average grain yield for all sites of 7940 kg ha^{-1}, which is 765 kg more than the standard. The highest yield of the Vitez variety was achieved in conditions of intensive production at the location of Pančevo 10375 kg ha^{-1}, Sremska Mitrovica 8163 kg ha^{-1}, Kikinda 7834 kg$ha^{/1}$.
It has a wide adaptability, satisfactory yield stability, as well as a good level of tolerance to drought and plant diseases. This new cultivar has a great potential for expansion in agricultural production.

Key words: barley, yield, breeding, quality

Introduction

Barley is one of the oldest domesticated crop. Similar to other cereals during the long cultivation history, it played a significant role in the development of agriculture, civilization, culture and agronomic science as part of other scientific disciplines. First, it was used only for human consumption, but over thousands of years use has changed its role, and nowadays it is primarily used as food for domestic animals and for the production of malt, beer and distillate (Smith, 1999). Barley grain represents a high quality feed and, according to the quality of barley variety, it is often compared to wheat and corn. A significant share of chaff in grains of dry matter, which is not nutritionally usable for non-poultry and poultry, is a major barley disadvantage, but numerous studies have shown that barley can be of equal or better quality than wheat and corn (Bowland, 1974). Given the wider adaptability in relation to maize, barley represents significant crop in dry and colder regions where the cultivation of corn is limited. The limiting factor in the production of barley is the soil pH where barley on soil with a pH of 5.5 already has a difficulty in growth and development. Bearing this in mind, as well as the growing climate changes, the new barley breeding model clearly directs the selection process exclusively in order to increase yield, but also includes a number of other important features. Due to the breeding work and improved cultivation technology in the past century, the overall production of cereal crops has increased significantly, where greater progress has been made in Europe, America and Canada (Peltonen-Sainio, 2007).

The current varieties of agricultural plant species have 60-80% greater genetic potential than varieties and populations raised at the beginning of the last century (Mladenov et al., 2002). The breeding work in the Institute is partly aimed at completing the production palette of our seed production, i.e. creating and obtaining a new variety of colored barley that will have a good potential for yield, high yield potential, as defined by Sadras and Calderini (2009), then good quality and high resistance to diseases (Pržulj et al., 2016).

More recently, the efforts of breeders have been focused on the quality improvement of breed during the creation of new barley varieties, primarily to reduce the content of phytic acid, improve digestion, reduce the chaff percentage, increase protein quality and starch content (Pržulj and Momčilović, 2003).

The aim of this paper is to present a new variety of winter-colored barley, with its important agronomic and production qualities. The "Vitez" variety is one of the elements of production with economical and stable production potential with adequate production technology.

Material and Methods

The basic material for this work was the pure line BL 75/14 formed by crossing the varieties Etincel and Krajišnik. The simple crossing of these varieties was carried out in 2007. The hybrid material is grown according to the pedigree method. The phenotypically uniform line marked BL 75/14 was separated from 2013 by the sixth generation. All the more important and necessary traits were monitored during preliminary and comparative trials in the experimental field of the Agricultural Institute of the Republic of Srpska, in comparison with about fifty varieties (old and newer), as well as the leading several varieties of winter barley in production in our area.

Under the same working title, this line was registered for approving in 2016 to the Variety Commission in Belgrade, then investigated in two years, 2016/17 and 2017/18 at seven sites (Novi Sad, Pančevo, Sremska Mitrovica, Kikinda, Sombor, Požarevac, Kruševac) and finally recognized based on results obtained in 2018. By this approving of the Variety Commission from Belgrade, the variety of winter multi-rowed barley named "Vitez" is allowed to be introduced into production.

The variety Vitez was tested in experiments in 5 repson $5m^2$ unit plot on each of six location and tested along with other lines in relation to the standard Rudik. Important features were analyzed such as: yield, resistance to lodging, resistance to low temperature, stem height, protein content, cellulose and fat content, 1000 grain weight and bulk density.

Results and Discussion

According to the results of the Variety Commission two-year testing, the variety Vitez achieved the average grain yield for all sites of 7940 kg ha^{-1}, which is 765 kg more than the standard.

The highest yield of the Vitez variety was achieved in conditions of intensive production at the location of Pančevo 10375 kg ha^{-1}, Sremska Mitrovica 8163 kg ha^{-1}, Kikinda 7834 kg ha^{-1}, etc. In the two-year trials at the Economy of Institute, this variety achieved yield over 8000 kg ha^{-1}, and at four sites (Bijeljina, Gradiška, Dubica, Srbac) according to the results of the Agency for the provision of professional services in agriculture the average yield was more than 7500kg ha^{-1}. In the micro experiments at the Economy of Institute during three-year comparative trials, this variety achieved yield of 8805 kg ha^{-1}.

Table 1. Average two-year grain yield of variety Vitez and standard (kg ha^{-1})

Variety	Sites							
	Kikinda	Kruševac	Novi Sad	Pančevo	Požarevac	S. Mitrovica	Sombor	x
Vitez	7834	7596	7191	10375	7140	8163	7283	7940
Rudnik check variety	6512	7395	7202	9713	6088	7572	5742	7175

The variety Vitez belongs to a group of medium-early barley varieties, with a protein content of about 11.5%. In the local agroecological conditions and at flowering stage in the first decade of May, it shows excellent resistance to lodging. The stem height is about 75 cm, with a moderately compacted ear. This variety is characterized by a large and round grain, with absolute mass of about 44g and excellent volume weight of about 70 kg. The flag leaf is semi-upright, moderately wide, light green and, as such, is maintained until the end of milk lactic ripeness, when it falls slightly into a horizontal position. The ear is with a long, sparse spread awn, standing upward from the offshoot, then taking the curved position with ripening. The main goal of the selection in the creation of this barley variety was to increase yields while retaining other agronomic properties and quality at least at the level of standard. In the overall process, the presence of an interaction between the genotype and the ecological environment is unavoidable, where different reactions of the varieties occur due to the conditions of the environment in which it is cultivated (Kang, 2004). The grain filling period plays an important role in the formation of yield. Due to the unfavorable agroecological conditions in a local production terms during the second half of June and the first decade of July, grain yield can not be increased by prolongation of the vegetation period (Pržulj et al., 2002). The early winter barley varieties end their grain filling period before the appearance of unfavorable agroecological conditions, but they are characterized by a lower genetic potential for yield. The variety Vitez belongs to the group of a medium-sized varieties, characterized by a balanced relationship between the dynamics of development and grain filling in relation to ecological conditions, i.e. excellent harvest index over 40%. The morphological, chemical and physical properties of grains are the main indicators of the quality of livestock barley. The quality effect of the barley for animal feed is measured by the type of domestic animals for which the diet is intended. The physical properties such as hectolitre mass, 1000 grain mass and grain shape are still the main characteristics that determine the price of livestock barley on the market. A strong positive correlation between the yield of grain crops and the number of grains per square meter was determined by many researchers (Krishna, 2014; Philipp et al., 2018), as well as the yield limit by acceptor of assimilates (Borras et al., 2012).

The existence of a positive correlation between the number of grains per ear and the development duration of ear during the second half of the panicle formation phase has been determined by many authors (Miralles and Ricgarsd RA, 1998; Pržulj and Momčilović, 2011). By manipulating the length of the formation phase, i.e. by extending the period of its duration, the number of grains per unit area increases, and therefore the yield (González et al., 2011). The hectolitre mass is one of the most widely used indicator of barley quality and represents a mass of grains in the volume of 100 liters. The hectolitre mass of the chaff barley ranges in wide limits, i.e. between 52-72 kg hl^{-1}.

The hectolitre mass value of the natural sample of Vitez variety in the perennial average was around 68 kg hl^{-1}, and the 1000 grain mass was about 42 g. (Table 2).

According to the protein content depends largely on the influence of external factors. The protein content of the Vitez variety was at the level of standard, indicating that the high quality varieties can be obtained by the selection process.

Table 2. Grain characteristics of barley variety Vitez compared to standard variety

Characteristic	Vitez	Check variety - Rudnik
Flowering phase	beginning of May	beginning of May
Stem height	87 cm	90
Proteine content (%)	11,7	11,8
Cellulose content (%)	4,5	5,4
Content of I class grain (>2,5mm)	77,3	80,0
Fat content (% na s.m.)	2,2	1,7
1000 grain mass	43,2 g	44,4
Volume weight	70,6 kg	71,2

Table 3. Average height, lodging and ear formation of barley variety Vitez compared to standard variety

Location	N Sad	Kikinda	Pancevo	Sombor	S Mitr.	Krusevac	Požare
(stem height, cm)							
Vitez	93	98	93	88	85	82	90
Rudnik	95	94	95	84	81	84	91
Lodging							
Vitez	1	1	1	1	1	1	1
Rudnik	1	1	1	1	1	1	1
Difference in ear formation compared to standard (days)							
Vitez	-1	+1	+1	+1	+1	-1	0

The variety should be you mean Vitez, formed an ear in average of 1 day later compared to the standard variety (Table 3). It is known that high temperatures and lack of precipitation during

the growing period as well as grain filling often have a crucial effect on yield formation. For this reason, one of the criteria during the process of creating new varieties may be favoring genotypes with shorter vegetation period and more waxy coatings in the leafs middle surface, and as the most important an early ear formation (end of April, early May). In grain crops, especially in barley, the crop lodging occurs due to poor genetic resistance to lodging, stem aging, insect damage and phytopathogenic fungi, when grain quality is significantly compromised. The variety Vitez with an adequate production technology, primarily nitrogen input (about 80 kg of pure N ha^{-1}), has an excellent resistance to lodging, as this has been confirmed in several years of vegetation, i.e. in different production conditions.

Conclusion

By the recognition of Vitez variety, multi-colored, winter barley, the production assortment of our region is richer for one excellent variety, characterized by a high genetic potential of grain, excellent resistance to low temperatures and lodging, large grain, excellent volume weight, and high protein content as a very important component in the production of animal feed.

Referencess

Bowland, J.P. (1974). Comparison of several wheat cultivars and a barley cultivar in diets for young pigs. *Can. J. Anim. Sci.* 54, 629-638.

Borras-Gelonch, G., Rebetzke, J.G., Richads, A.R. & Romagosa, I. (2012). Genetic control of duration of pre anthesis phases in wheat (*Triticum aestivum* L.) and relationships to leaf appearance, tillering, andry matter accumulation. *Jourrnal of Experimental Botany*, 63, 69-89.

Gonzalez-Navarro, O.E., Griffiths, S., Molero, G., Matthew, P., Reynolds, M.P. & Slafer, G.A. (2016). Variation in developmental patterns among elite wheat lines and relationships with yield, yield components and spike fertility. *Field Crops Research*, 196, 294-304.

Kang, M.S. (2004). Breeding: Genotype-by-environment interaction. *In Goodman RM (ed) Encyclopaedia of Plant and Crop Science*. Marcel-Dekker, New York. 218-221.

Krishna, A., Ahmed, S., Pandey, H.C. & Kumar, V. (2014). Correlation, Path and Diversity Analysis of Oat (*Avena sativa* L.) Genotypes for Grain and Fodder Yield. *Journal of Plant Science & Research*, 2, 1-9.

Miralles, D.J. & Richards, R.A. (1998). *Sensitivity to fotoperiod during the reproductive phase changes grain number in wheat and barley*. Combined Conference Abstaracts, 42nd Anuual ASBMB-38th Annual ASPP and 20th Annual NZSPP Conferences, Adelaide, Australia.

Mladenov, N., Denčić, S., Hristov, N. & Kobiljski, B. (2002). *Doprinos oplemenjivanja pšenice povećanju prinosa*. Zbornik referata XXXVI Seminar agronoma, 175-183.

Peltonen-Sainio, P. & Rajala, A. (2007). Durtation of vegetative and generative development phases in oat cultivars released since 1921. *Field Crops Research*, 101, 72-79.

Philipp, N., Weichert, H., Bohra, U., Weschke, W., Schulthess, A.W. & Weber, H. (2018). Grain number and grain yield distribution along the spike remain stable despite breeding for high yield in winter wheat. *PLoS ONE* 13(10): e0205452. https://doi.org/10.1371/journal.pone.0205452.

Pržulj, N. & Momčilović, V. (2002). *Novi Sad barley varieties for the agroecological conditions of Southeastern Europe*. Zbornik radova Instituta za ratarstvo i povrtarstvo, 36, 271-282.

Pržulj, N. & Momčilović, V. (2003). *Genetics and breeding for characters determining quality in fodder barley*. Zbornik radova Instituta za ratarstvo i povrtarstvo, 38, 131-144.

Pržulj, N. & Momčilović, V. (2011). Characterization of vegetative and grain filling periods of winter wheat by stepwise regression procedure. I. Vegetative period. *Genetika*, 43, 349-361.

Pržulj, N. (2016). *Prinos strnih žita*. Monografija. Akademija nauka i umjetnosti Republike Srpske. Banja Luka.

Sadras, V.O. & Calderini, D. (2009). *Crop Pfysiology - aplications for genetic improvement and agronomy*. Elsevier.

Smith, D.L., Dijak, M., Bulman, P., Ma, B.L. & Hamel, C. (1999). Barley: Physiology of yield. In: *Sith, D.L., Hamel, C. Crop Yield Physiology and Proces. Berlin*, Springer-Verlag, 67-107.

Original scientific paper

Rapeseed Oil as a Biodegradable Lubricant

Miloš Nožinić[1], Vesna Bojić[1], Nikola Kezić[2], Dragan Romčević[3], Nemanja Babić[4], Ivana Petrović[4]

[1]*Public Institution Agricultural Institute of the Republic of Srpska, Knjaza Miloša 17, Banja Luka, Republic of Srpska, B&H*

[2]*Bimal, d.d., Bijeljinska 9, Brčko Distrikt, B&H*

[3]*National park "Kozara", Vuka Karadžića 43, Prijedor, Republic of Srpska, B&H*

[4]*Tehnosint d.o.o., Ulica Episkopa Platona 30, Laktaši, Republic of Srpska, B&H*

Corresponding author: Nožinić, M., milosn@blic.net

Abstract

Rapeseed oil represents an excellent raw material for numerous technical applications. In the Public Institution Agricultural Institute of the Republic of Srpska, Banja Luka, it has been used for the production of biofuels and biodegradable lubricants, as a component of body friendly soaps as well as human consumption. This paper deals with the characteristics of rapeseed oil for the production of biodegradable lubricants for chainsaw and machinery in carpentry. Eight rapeseed cultivars from the field trial in Banja Luka were analyzed on oil content and composition of fatty acids. In order to compare these traits among different oil crops, the same traits were analyzed in linseed, sunflower and soya oil. On the basis of the research results, it was determined that rapeseed oil matched main quality standards for lubricating chainsaw and machinery in carpentry. Favorable traits of rapeseed oil for chainsaw were discussed (pour point, flash point, biodegradability) as well as certain disadvantages (tendency to rancidity, low kinetic viscosity). Recommended value of the kinetic viscosity for chainsaw was obtained by adding synthetic improver Viscoplex. The rapeseed oil viscosity could be increased in a natural wayby adding of castor oil, what will be a subject of future research.

Key words: rapeseed, rapeseed oil, biodegradable lubricant

Introduction

Before the war events, rapeseed production in Bosnia and Herzegovina had been quite stabile with harvest area from 4.155 ha in 1989 to 5.019 ha in 1983. Though the average yields were low (about 1,5 t ha^{-1}), field research results indicated on high potentials for that crop from the lowland regions to the mountain karst plateaus (Kondić, 1989; Kondić, 1990).

Thanks to the subvention with diesel in the period (1994-1998), the area of the rapeseed in the Republic of Srpska had increased to 1.749 ha in 1998, then suddenly fell after cancelling the subvention (Kondić et al., 2008). The privatization of the oil company "Bimal" in 2002 has been related with gradual increase of rapeseed production in Bosnia and Herzegovina.

Table 1. Area (ha) and yield (kg ha^{-1}) of rapeseed in Republic of Srpska in the period 2010-2018

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Ha	489	622	165	682	883	838	1.337	1.978	2.691	2.807*
Kg ha^{-1}	1.926	2.100	2.000	2.400	2.000	2.100	2.400	2.800	2.729	-
Total (t)	942	1.305	337	1.642	1.785	1.752	3.341	5.480	7.343	-

*Rapeseed sown in the Autumn 2018

Rapeseed production "renaissance" in the recent years (tab. 1) resulted fromcoordinated activities by seed buyer (company "Bimal"), seed companies (Pioneer, Institute for Field and Vegetable Crops, Agrimatco, Syngenta) and the PI Agricultural Institute of RS, Banja Luka (abbr. Institute Banja Luka).

Field research activities on the rapeseed (Nožinić et al., 2010) have been extended on the field of oil crops processing since 2011 (Nožinić et al., 2014). Cold extracted rapeseed oil has been used like edible oil, supplement to the mineral diesel in tractors, raw material for biodiesel, component for body friendly soaps and biodegradable lubricant.

All mentioned technologies based on cold extracted rapeseed oil (as well as other vegetable oils) ought to find practical applications in the ecologically orientated sectors of forestry (National parks), industry and agriculture. This paper deals with the characteristics of rapeseed oil in the function of biodegradable lubricant for chainsaw, machinery in carpentry and related applications. The aim of the research was to estimate the suitability of rapeseed oil for lubricating purposes.

Material and Methods

The observations regarding the oil extraction productivity from more rapeseed cultivars have been done on the oil press machine and related equipment in the Institute Banja Luka. The contents of free fatty acids (FFA) in the oil was determined in the same institution using method of titration with KOH according to ISO 729.

The determination of the oil the content (%) in eight rapeseed cultivars from the field trial in Banja Luka in 2009 as well as the determination of the fatty acid composition (%) in the cold extracted rapeseed oil from these cultivars were done in the laboratory of "Bimal" Brčko. In order to compare these traits with the other oil crops, the same analyses were done on three linseed cultivars (variety Olin, yellow seed variety from Zaječar, local linseed from Petrovac), the mixture of sunflower seed (varieties Duško and Rimi) and four BL soya varieties (Sana, Sonja, Marina, Milica). The content of oil is determined by method ISO 659 and the content of fatty acids by the methods ISO 5508 and ISO 5509.

Table 2. Methods for determination of technical characteristics of rapeseed oil

Analysed trait	Measure	Methodology
Density at 15°C	g cm^{-3}	ASTM D 1298-99
Kinematic viscosity at 40°C	mm^2s^{-1}	ASTM D 445
Kinematic viscosity at 100°C	mm^2s^{-1}	ASTM D 445
Index of viscosity		ASTM D 2270
Flash point	°C	ASTM D 92 ASTM D 93
Pour point	°C	ASTM D 97

The technical traits of the rapeseed oil (from hybrid DO10 - company Pioneer, harvested in 2018) and rapeseed oil with the addition of improver Viscoplex have been tested in the laboratory of Tehnosint d.o.o. from Laktaši (tab. 2). Technical characteristics of castor oil were determined too.

Forest workers in the national park "Kozara" have tested chainsaw biodegradable rapeseed oil during the forest works in the early spring in 2019. Two local carpenters have tested pure rapeseed oil for greasing of the machinery for cutting of wood.

Results and Discussion

Any application of rapeseed oil demands high quality rapeseed without weeds and soil particles. Weed parts in the rapeseed increase moisture in the seed mass provoking rancidity

process. The Institute Banja Luka use unique technology for eliminating of weeds from rapeseed based on the gravitation principle. Some weeds (eg. *Sinapis arvensis*), which have similar shape like rapeseed cannot be eliminated in this way, so the rapeseed must not be grown on the plots contaminated with these weeds.

Rapeseed oil deserves special attention for its unique characteristics. Among many applications, it can be used as a lubricant for chainsaw and machinery in carpentry as well as producing of wood dust for smoking of meat.Obtained quantity of cold extracted rapeseed oil after pressing depends on the genotype's genetic potential, oil availability, moisture content in grain as well as air temperature and humidity in the working space.

As biodegradable lubricants are more expensive than mineral ones, the yield of oil from hectare has a great importance for the economical production economy. As rapeseed hybrids had higher seed yield than varieties, they offered more oil per ha^{-1} than varieties. Similar results were obtained in the varietal trials in Zagreb (Pospišil et al., 2014).

Simmilar content of oil (determined in laboratory) in 8 cultivars (tab. 3) did not result with simmilar oil content obtained on the press machine (25-36%). Though it appears rare, some rapeseed cultivars retain oil in the grain after pressing. It happened with spring rapeseed variety Jovana from the Institute Novi Sad in the production trial in Banja Luka in 2010 and some rapeseed lines. Not only, is it a case with some rapeseed cultivars. In the years with poor oil syntesis (extreme drought), auger press machine could not catch oil from soybean. The problem of the "trapped oil" should be studied in detail. If it is related with genotype traits, oil producers should avoid such cultivars.

The disadvantage of all vegetable oils is due to the fact that they are more or less sensitive to rancidity processes. In order to slow rancidity process down, agronomy of oil crops and their processing should be considered as highly related processes.

Hydrolytic rancidity develops in the presence of water molecules in oil. The reaction leads to the decomposition of triglycerides into free fatty acids and glycerol. Hydrolytic rancidity can develop even in the oil extracted from the seed with normal content of water (7-9% for rapeseed), if the oil lies too long on the organic deposal (parts of shells associated with water molecules) or in a case of slow sedimentation (sunflower). Fortunately, the sedimentation in the fresh rapeseed oil takes place fast. In addition, the process of oil cleaning can be accelerated by filtration.

The seed harvested with a normal content of moisture can absorb additional moisture from wet storage, what can accelerate hydrolytic rancidity of oil. Some press machines "obstruct" extraction of oil from such seed, offering the signal for testing the seed moisture.

If the content of free fatty acids (FFA) exceeds 3%, it indicates on advanced hydrolytic rancidity. Such oils are not recommended neither for human consumption nor for technical purposes. Rapeseed oil with high content of free fatty acids did not produce quality biodiesel (Nožinićet al., 2014). Stored under proper conditions, the rapeseed oil (hybrids PT200CL, PX111CL, PT234, PR46W14) had not changed content of free fatty acids from August 2018 to March 2019. Advanced hydrolytic rancidity can increase oil acidity causing corrosion of machinery metal parts.

The reaction of oxidative rancidity is catalyzed by sunlight. Malodorous and highly volatilealdehydes and ketones appear after this reaction.Oxidation primarily occurs with unsaturated fatty acids, especially linolenic acid. For that reason, the cultivars with lower content of linolenic acid (under 3%) have the advantage for technical applications (biofuels, lubricants), while the cultivars with higher content of linolenic acid (over 9%) are recommended for human consumption. Deng and Scarth (1998) reported that the cultivar Stellar had very low content of linolenic acid (about 2,5%) that was relatively stable over environments.

The content of linolenic acid varied from 4,9-8,3% in the rapeseed varietal trial in Banja Luka (tab. 3). More rapeseed genotypes, the higher variability of that trait. The content of linolenic acid in the gene bank (20 genotypes) in Novi Sad varied from 4-11% (Marinković and Marjanović–Jeromela, 2006).

In addition to the genetically conditioned heritage of fatty acids composition, the temperature regime in the generative period has a significant influence on that trait. Cooler weather conditions in the generative period were favorable for higher content of linolenic acid (Merrien et al., 2007). Warmer conditions during the rapeseed development caused decreased synthesis of linolenic acid and increased synthesis of saturated fatty acids and oleic acid (Deng and Scarth, 1998). As the production of rapeseed in our country takes place under various climate conditions, it is an opportunity for the manipulations with the composition of fatty acids.

Thanks to very low pour point (-23°C), rapeseed oil can be used for forest works in the winter conditions (tab. 4). This rapeseed oil trait is related with very low content of saturated fatty acids (palmitic acid C16:0;stearic acid C18:0). All conventional vegetable oils have higher contents of saturated fatty acids than rapeseed oil (tab. 3). Linolenic acid (C18:3) has very strong influence on that trait too. The more linolenic acid the lower pour point of oil.

Table 3. Content of oil (%), free fatty acids (%) and composition of fatty acids (%) in eight rapeseed cultivars from field trial in Banja Luka in 2009

Cultivar	Oil (%)	FFA	C16:0	C18:0	C18:1	C18:2	C18:3	C20:0	C22:0	C22:1	C24:0
Slavica	48.0	0.72	4.8	1.4	68.9	16.4	5.9	0.8	0.2	0.3	005
Kata	47.5	1.65	4.7	1.4	69,7	15.9	6.1	0.7	0.2	0.2	0.07
Branka	46.4	1.10	4.4	1.5	68.3	15.4	5.9	1.2	0.2	1.9	0.06
Herkules	47.5	0.95	4.6	1.2	68.8	18.3	4.9	0.7	0.2	0.04	0.06
Nena	47.5	1.81	4.4	1.4	66.3	16.0	6.4	2.1	0.2	1.6	0.1
W09	47.6	2.54	4.7	1.3	68.9	16.8	6.2	0.7	0.2	0.1	0.06
D04	48.4	1.12	4.4	1.4	70.3	16.2	5.7	0.7	0.2	0.05	0.07
D03	47.4	0.74	4.0	1.5	67.0	17.8	8.3	1.1	0.2	0.6	0.1
Mean	47.54	1.33	4.5	1.39	68.5	16.6	6.18	1	0.2	0.60	0.07

Table 4. Content of oil (%), free fatty acids (%) and composition of fatty acids (%) in oily crops

Plant species(cultivar)	Oil	FFA	C16:0	C18:0	C18:1	C18:2	C18:3
Linseed (Olin)	40.2	0.51	5.8	4.4	20.6	12.6	54.2
Linseed (yellow seed, Zajačar)	44.4	0.69	5.2	3.6	18.0	15.2	56.0
Linseed (Petrovac)	-	0.57	5.7	3.7	17.6	14.3	57.6
Sunfower (Duško, Rimi)	-	0.29	5.8	4.1	24.1	63.9	0.2
Soya (mean - 4 BL varieties)	20.5	0.74	10.2	4.4	22.5	53.8	6.9
Rapeseed (mean, tab.)	47.54	1.33	4.5	1.4	68.5	16.6	6.18

High flash point of rapeseed oil offers safer working conditions due to the risk of fire. Generally, vegetable oils have higher flash points than petroleum based products (tab. 5). Cold extracted vegetable oils have higher falsh point than the vegetable oils extracted by hexanes. Some molecules of hexanes remain in that oil changing this technical trait.

Mineral chainsaw oils cause environmental pollution and health problems. Theseedlings of pedunculate oak had the lowest height on the plots treated with mineral oil while the highest growth was registered on the plots treated with biodegradable oil (Oršanićet al., 2008a). They determined that the increased concentration of mineral oil may decrease seedling germination of pedunculate oak while biodegradable oil can increase it (Oršanićet al., 2008b).

Forest and wood workers exposed to wood dust, aerosols from mineral oils for chainsaw and petroleum aerosols suffer of respiratory problems, diseases of central nervous system as well as the appearance of sinus-nasal cancer (Hayes et al., 1986; Leclerc et al., 1994; Demers et al., 1995; Gordon et al., 1998; Innoset al., 2000; Siew et al., 2012). Having in mind mentioned problems, some EU countries turned to the biodegradable oils (Scandinavian countries, Germany) while Austria banned mineral oils in forests works.

As pure vegetable oils have lower kinematic viscosity then recommended for chainsaw, these oils can be used for small scale jobs in forest. Wood dust produced in this way can be used for smoking of meat or similar purposes. Local carpenters prefer pure rapeseed oil too for health risks as well as cleaner surface of wood after the contact with vegetable oil. Pleasant "cabbage" smell of rapeseed oil has had a positive response by workers. Moreover, this oil can be used in their kitchen. Users also reported that the rapeseed oil was easier to clean from clothes and equipment than mineral ones.

Table 5. Main technical characteristics of pure rapeseed oil from Pioneer hybrid PT200CL, rapeseed oil with addition of improver of viscosity and standard mineral oil (ExtrolTesterol E-100) for chainsaw

Characteristics	Measure	Pure rapeseed oil	Pure rapeseed oil + 10% of improver	Standard mineral oil
Density at 15°C	g cm^{-3}	0.919	0.921	0.887
Kinematic viscosity at na 40°C	mm^2 s^{-1}	36	101	108
Kinematic viscosity at 100°C	mm^2 s^{-1}	8	23	13
Index of viscosity		201	254	110
Flash point	°C	>290	>290	230
Pour point	°C	-23	-27	-24

However, professional forest works demand higher oil kinematic viscosity, what is related with slower oil consumption. By adding viscosity index improver (Viscoplex 10-950) in the proportion of 10% to the rapeseed oil, this oil got excellent viscosity values for chainsaw (tab. 5).

This synthetic improver is recommended for using in the production of environmentally friendly lubricants. As castor oil has very high kinetic viscosity (at 40°C, 252mm^2s^{-1}; at 100°C, 19,1 mm^2 s^{-1}), it should be tested as a natural supplement for improving rapeseed oil viscosity. Even with the increased cost, the benefits for workers and the environment make vegetable based oils an attractive alternative.

Conclusion

Pure rapeseed oil is suitable as a biodegradable lubricant for small scale jobs in forest and agriculture, as well as lubricating of machinery in carpentry. Rapeseed oil with the synthetic improver Viscoplex is recommended as a biodegradable lubricant for professional forest jobs.

References

Demers, P.A., Kogevinas, M., Boffetta, P., Leclerc, A., Luce, D. & Gérin, M. (1995). Wood dust and sino-nasal cancer: pooled reanalysis of twelve case-control studies. *Am J Ind Med*., 28,151–166.

Deng, X., Scarth, R. (1998). Temperature effects on fatty acids composition development of low-linolenic oilseed rape (*Brassica napus* L.). *J.A.O.C.S.*, *75*(7), 759–766

Gordon, I., Boffetta, P. & Demers, P.A. (1998): A case study comparing a meta–analysis and a pooled analysis of studies of sinonasal cancer among wood workers. *Epidemiology*, 9(5), 518–524.

Hayes, R.B., Gerin, M., Raatgever, J.W. & de Bruyn, A. (1986). Wood–related occupations, wood dust exposure, and sinonasal cancer. *Am J Epidemiol*., 124(4), 569–577.

Innos, K., Rahu, M., Rahu, K., Lang, I. & Leon, D.A. (2000): Wood dust exposure and cancer incidence: a retrospective cohort study of furniture workers in Estonia. *Am J Ind Med*., *37*(5), 501–511.

Kondić, J. (1989). Uticaj gustoće sjetve na prinos uljane repice u kraškim poljima. *Naučna sveska*,11/89, 25–31, Banja Luka.

Kondić, J. (1990). Uticaj sorti i rokova sjetve na prinos uljane repice na kraškim poljima. *Agronomski glasnik*, Zagreb, 6/90, 351–359.

Kondić, J., Marinković, R. & Mijanović, K. (2008). *Uljana repica–monografija*. Poljoprivredni institut Republike Srpske, Banja Luka.

Leclerc, A., Martinez Cortes, M., Ge´rin, M., Luce, D., Brugère, J. (1994). Sinonasal cancer and wood dust exposure: results from a case-control study. *Am J Epidemiol*, 140, 340–349.

Marjanovic–Jeromela Ana (2005). *Genetic divergency and variability of rapeseed* (Doctoral dissertation), Faculty of Agriculture, University of Novi Sad.

Marinković, R., Ana Marjanović–Jeromela (2006). Oplemenjivanje ozime uljane repice u Institutu za ratarstvo i povrtarstvo Novi Sad (pregledni rad). *Zbornikr adova*, 1(42), 173–189.

Merrien, A., Krouti, M., Dechambre, J., Garon, V. &Evrard, J. (2007). *Contribution to understand the fluctuation of linolenic acid profile in winter oilseed rape grown in France*. Proceedings from The 12th International Rapeseed Congress in Wuhan, China (March 26-30, 2007), 95-97.

Nožinić, M., Đurašinović, G., Bojić Vesna, Suljkanović, Š. & Berić, M. (2010). Analiza makro ogleda sa ozimom uljanom repicom na lokalitetu Banja Luka u 2008/09. godini. *Agroznanje, 11*(3), 189–196.

Nožinić, M., Đukić, V., Pržulj, N., Bojić Vesna, Cvijanović Tatjana &Vlačina, M. (2014). *The experience in the production of liquid biofuels*. Paper presented at the IV International Scientific Conference "From Crises towards Development". Proceedings of University for Bussiness Studies, Banja Luka, 901–909.

Oršanić, M., Horvat, D., Pernar, N., Šušnjar, M. & Drvodelić, D. (2008a). Utjecaj mineralnog i biorazgradivoga ulja na rasadničku klijavost i rast sadnica hrasta lužnjaka (*Quercusrobur* L.). *Šumarski list*, 132(1-2), 3–9.

Oršanić, M., Horvat, D., Pernar, N., Šušnjar, M., Bakšić, D. & Drvodelić, D. (2008b). Growth of Pedunculate Oak Seedlings under Soil Contamination by Mineral and Biodegradable Oils. Croatian Journal of Forest Engineering: *Journal for Theory and Application of Forestry Engineering,* 29(2), 155–162.

Pospišil, M., Brčić Marina, Pospišil Ana & Butorac Jasminka (2014). Yield and yield components of investigated rapeseed hybrids and cultivars. *Poljoprivreda,* 20(1), 3–9.

Siew, S.S., Kauppinen., T., Kyyrönen, P., Heikkilä, P. & Pukkala, E. (2012). Occupational exposure to wood dust and formaldehyde and risk of nasal, nasopharyngeal, and lung cancer among Finnish men. *Cancer Manag Res*., 4, 223–232.

Original scientific paper

Improving the fruit quality of Crimson seedless (*Vitis vinifera* L.) using vine trunk girdling and GA3 as an agrotechnical tool

Dushko Nedelkovski, Klime Beleski, Goran Milanov, Viktor Gjamovski, Biljana Korunovska

University „Ss.Cyril and Methodius", Institute of Agriculture, 1000 Skopje, Republic of North Macedonia

Corresponding author: Dushko Nedelkovski, duskosk8@yahoo.com

Abstract

Crimson Seedless is grape variety developed by David Ramming and Ron Tarailo in USDA Fruit genetics and Breeding Research Unit, Fresno, California. It is a late-season red seedless table grape variety, it ripens in October and can be held on the vine through late November if the weather permits. This variety primary production problem is the small berry size and the insufficient berry color. To increase the berry size and color use of giberellic acid and girdling can be applied as a regular production practice. In this study the influence of the applied GA3 and vine trunk girdling practice on the berry size color and sensory characteristics were examined.

Two variants were established: the first one with applied giberellic acid (GA3) and the second one with GA3 and girdling the vine trunk. According to the obtained results the berry from the second variant (GA3 + trunk girdling) had better coloration, slightly higher sugar content and berry weight compared with the berries treated only with GA3.

Key words: Crimson seedless, GA3, trunk girdling

Introduction

As years pass the market for table grape becomes more and more demanding for the overall quality of this fruit. The market for table grapes varieties is divided on seeded and seedless varieties. The seedless varieties are mainly used as raisins and for fresh consumption and the

seeded varieties are mainly for fresh consumption and grape juice or concentrate (Mullins et al., 1992). The look, shape, color and size of the berries become the most demanding parameters for the costumer. Berry size is one of the most demanded quality parameters on the market, due to the fact that most of the people eat with their eyes.

More and more publications are written on how to improve the uniformity of the berries in the grape cluster as well as how to improve the color of the berries.

Treating the vine with growing regulators such as gibberelian acid (GA3) in different stages of the berries development it turned out to be a good practice to increase the size of the berries. Winkler (1962) described that berry growth is caused by rapid cell division which is followed by rapid cell enlargement that lasts 3 to 4 weeks after anthesis.

In seedless varieties the applied GA3 increases the size of the cell which allows the berry to take larger amounts of water and soluble solids without changing pressure potential (Casanova et al., 2009; Ferrara et al., 2014). If GA3 is sprayed at anthesis it will reduce the number of flowers in the cluster and if second spray is done at berry formation it will increase berry size (Dokoozlian et all.; Harrell, D.C et all., 1987).

Girdling is a practice that consists of removing a cane or trunk bark (phloem tissue) in the shape of a ring. The effect of a complete girdle is to interrupt the regular movement of assimilates so that the level of carbohydrates and plant hormones increase in the part above the wound (Winkler, 1962). The effect of girdling on the grape berry size and color is related to the development stages of the berries. If the girdling is performed after anthesis (at pea size) the effect will be increasing the berry size and if it is performed when the berries start ripening (softening of berries) it will advance maturity and improve berries color (Winkler A.J., 1962; Ferrara G. et all., 2014; Rateb T. et all., 2012). In most of the studies girdling and use of GA3 are performed as separate practices.

Our idea was to investigate the effect of GA3 and GA3 plus girdling on the overall quality of the grapes of Crimson seedless.

The main goal of this study was to produce grapes with higher market values (bigger and good colored berries) and higher yields in overall.

Materials and Methods

The study was performed in southern part of the country in Gevgelija near the border with R. of Greece. It was two years study, harvest 2017 and 2018. Fifty vines were investigated in this study, twenty-five vines for each of the two variants.

The first variant that we used as control variant was the one sprayed with GA3 (two times sprayed, first spraying at full bloom and second spraying during the formation of the berries, size of berries 6-7 mm).

The second variant was sprayed with GA3 during the same periods as the previous variant and also girdling was applied after anthesis, when berries were at pea size.

The treatments were performed to increase the size of the berries and also to improve the color of the berries (anthocyanin level). All other treatments were the same at both variants.

To determine the quality level of the produced berries mechanical analysis of the grape cluster and berries were done according to methods described by Bozinovic (2010).

The chemical composition of the grape juice was analyzed for: pH; soluble solids, titratable acids and total anthocyanins, all analysis were performed according to suggested method from OIV.

A tasting evaluation was also performed of the grapes obtained from both variants according to the method described by Roychev (2014).

Results and Discussion

Grape cluster analysis show slight differences in the weight of the grape cluster between the variants which can be confirmed from the values for length and width of grape cluster. In both years of the investigation the variant with girdling had higher values for weight of clusters compared to the variant only with GA3 applied.

During the first year of the investigation the GA3 variant had average cluster weight of 406.7 g, the other variant with GA3+girdling had an average value of 467.8 g.

Increase in the weight of grape clusters was noticed at theGA3 variant 670.6 g compared to GA3+girdling variant 568.9 g in the second year of the study.

The length of grape clusters was also analyzed: GA3 variant had smaller clusters but no significant differences were observed between the variants. These values for GA3 variants were from 20.39 to 18.61cm and for the GA3+ girdling from 22.56 to 24cm.

For the width of the grape clusters no significant differences between the variants were determined: for GA3 values the variants were from 12.06 to 13.06cm and for GA3+girdling from 13.89 to 15.78cm.

Table 1. Mechanical structure of grape cluster and grape berries from the variety Crimson Seedless

N	Indicators	Crimson Seedles GA3	Crimson Seedles GA3 + girdling	Crimson Seedles GA3	Crimson Seedles GA3 + girdling
		2017		2018	
1	Weight of grape cluster, (g)	406,7±106,15	467,8±144,13	670,6±196,82	568,89±191,07
2	Weight of 100 berries, (g)	331,9±0,83	390,1±1,18	447,7±1,46	490,5±1,55
3	Length of grape cluster, (cm)	20,39±3,46	18,61±5,24	22,56±3,05	24,22±4,52
4	Width of grape cluster, (cm)	13,06±1,42	12,06±4,41	15,78±2,16	13,89±2,62
5	Length of grape berry, (mm)	22,35 ±2,26	21,408±3,08	25,56±2,86	27,32±2,87
6	Width of grape berry, (mm)	13,65±0,98	15,11±2,08	18,56±1,57	17,4±1,05
7	% of the peduncle	1,7	1,7	1,3	1,2
8	% of the berry skin	10,4	10,7	11,3	13,2
9	% of the berry flesh	87,9	87,6	87,3	85,5
10	Difference in weight of 100 berries, %	18%		10%	
11	Difference in length of grape berry, %	4%		7%	
12	Difference in width of grape berry, %	11%		7%	

Many authors (Winkler, 1962; Ferrara 2014; Rateb, 2012) concluded the positive effect of the GA3 and girdling application on berry size depending on the time of application. The results from table 1 suggest the positive effect of the girdling treatment despite of the application of GA3. During both years of the investigation the GA3+girdled variant showed higher weight of 100berries compared to the variant treated only with GA3. In 2017 the difference between these two variants was 18%, GA3 variant had 331.9g the girdling variant had 390.1g. These values for 2018 showed slightly smaller differences of 10% between the two variants, 447.7g for GA3 and 490.5g for GA3+girdling variant. The differences in the weight of the berries can be seen from the values for the length and width of grape berries. For harvest 2017 the length/width values were 2.35/13.65g for GA3 and 21.41/15.11g for GA3+girdling. For harvest 2018 the length/width values were 25.56/18.56g GA3 and for GA3+girdling 27.32/17.4g. The % of peduncle between the variants is nearly the same, they're in the range between 1.2 to 1.7%. For the % of berry skin no significant differences between the variants were determined and the range of the values was between 10.4 to 13.2%. The values for % of the berry flesh were in normal range which between the variant was from 85.5 to 87.9%.

Table 2. Chemical composition of grape juice from the variety Crimson Seedless

N	Grape variety	Sample treatment	Soluble solids (Brix)	Titratable acids (g/l)	pH	Total anthocyanins (mg/l GAE)
1	Crimson Seedless 2017	GA3	19,5	4,3	3,5	79.69
2	Crimson Seedless 2017	GA3 + Girdling	19	4,6	3,51	132.49
3	Crimson Seedless 2018	GA3	20	5,9	3,52	95.4
4	Crimson Seedless 2018	GA3 + Girdling	21	5,1	3,56	159.22

Analyses showing the composition of grape juice from Crimson seedless are presented in table 2. Significant differences were not observed between the two variants. The level of total soluble solids had 0.5 to 1 Brix difference between the variants for both years. The obtained values in both years are in very close range for the parameter titratable acids. During the first year the level of titratable acids was insignificantly lower: in theGA3 variant 4.3g/l to 4.6 g/l for the GA3+girdling. During harvest 2018 the obtained values were opposite, 5.9g/l for GA3 and 5.1g/l for GA3+girdling. The level of total anthocyanins is slightly higher in the girdled variants in both harvests 2017/18. The pH values in all variants during the first and second harvest are in the same range, from 3.5 to 3.56. GA3+girdling practice improves slightly the color of the berries which was visible and noticed from the evaluators during the grape evaluation.

Table 3. Sensory evaluation of the grape variety Crimson Seedless

N	Grape variety	Sample treatment	Appearance	Consistency	Taste	Typicality and Originality	Overal assessment
1	Crimson Seedless 2017	GA3	2,5	2,5	2,5	0,8	8,3
2	Crimson Seedless 2017	GA3 + Girdling	3	2,5	3	0,8	9,3
3	Crimson Seedless 2018	GA3	2,5	3	2,5	0,8	8,8
4	Crimson Seedless 2018	GA3 + Girdling	3	3	2,5	0,8	9,3

The sensory evaluation of the grape was performed in the Institute of Agriculture –Skopje. As mentioned before, 5 evaluators were involved. All results obtained from this evaluation were summarized and presented in table 3. From the results it can be seen that the GA3+girdeling variants had higher score for appearances, and taste in 2017. The consistency of the berries in both variants had the same score: both variants in 2018 had the highest score of 3points and in 2017 2.5points. The evaluators gave 0.8 points for all variants in both years for typicality and originality. From the overall score of assessment it can be concluded that both variants in both years of the investigation have a very high score, but the variant with the girdling vines had slightly greater points which comes from the points given about the appearance of the berries. As mentioned before, the appearance of the grapes is one of the most demanded parameters in the evaluation of the investigated grapes.

Figure 1. Crimson seedless grapes; harvest 2018

From left- variant treated with GA3 and from right- variant treated with GA3+girdling

Conclusion

If we compare the obtained results with the literature results, we can conclude that both treatments have positive effect on the mechanical analysis and sensorial evaluation of the analyzed grapes.

According to the results from the mechanical analysis the treatment that included GA3+girdlind had larger berry size, higher weight of 100 berries and the berries color was improved compared to the other treatment. The sensorial evaluation, on the other hand, showed that only the appearance of the berries at this variant had a higher rating from the evaluation panelists, for all other indicator both variants in both years had the same rating. By using both treatments GA3 and girdling as regular practice we can improve the quality of the grapes of Crimson seedless.

References

Божиновиќ З. (2010). *Ампелогрфија*. Агринет ДОО – Скопје, стр. 318.

Ройчев В. (2014). *Ръководство за упражнения по ампелография*. Академично издателство на Аграрен универзитет, Пловдив, стр. 253.

Casanova, L., Casanova, R., Moret, A. & Agustí, M. (2009). The application of Gibberellic acid increases berry size of “Emperatriz” seedless grape. *Spanish J. Agric. Res.* 7(4), 919–927.

Dokoozlian N., Luvisi D., Moriyama M., Schrader P., Cultural practices improve color, size of 'Crimson Seedless'. *California Agriculture*, Volume 49, Number 2.

Ferrara, G., Mazzeo, A., Netti, G., Pacucci, C., Matarrese, A.M.S., Cafagna, I., Mastrorilli, P., Vezzoso, M. & Gallo, V. (2014). Girdling, Gibberellic acid, and Forchlofenuron: Effects on yield, quality, and metabolic profile of table grape cv Italia. Am. *J. Enol. Vitic.* 65(3), 381–387.

Harrell, D.C. & Williams, L.E. (1987). The Influence ofGirdling and Gibberelic Acid Application at Fruitset on Ruby Seedless and Thompson Seedless Grapes. *American Journal of Enology and Viticulture*, 38(2): 3 83-88. http:// www.ajevonline.org/ cgi/ content/

Mullins, M.G., A. Bouquet and L.E. Williams (1992). *Biology of the Grapevine*. Cambrige University Press, Cambridge, Great Britain, 112-146. 11.

Rateb, T., Zahra, A. and Salameh, N.M. (2012). Influence of Gibberellic Acid and Cane Girdling on Berry Size of Black Magic Grape Cultivar. *Middle-East J. Sci. Res*., 11 (6), 718-722.

Williams, L.E. & Ayars, J.E. (2005). Water use of Thompson Seedless Grapevines as Affected by the Application of Gibberellic Acid (GA) and Trunk Girdling – Practices to Increase Berry Size. *Agriculture and Forest Meteorology*, 129, 85-94.

Winkler, A.J., Cook, J.A., Kliewer, W.M. & Lider, L.A. (1962). *General viticulture*. University of California Press, California.

Original scientific paper

Cultivation period influence of different *Lactuca sativa* L. and *Valeriana locusta* L. varieties on colour parameters and chlorophyll content

Lovro Sinkovič[1], Mojca Škof[1], Kristina Ugrinović[1]

[1]*Crop Science Department, Agricultural Institute of Slovenia, Ljubljana, Slovenia*

Corresponding author: Lovro Sinkovič, lovro.sinkovic@kis.si

Abstract

Lettuce and lamb's lettuce are popular fresh salad vegetables available to consumers all year round in many countries. The aim of the research was to compare three cultivation periods of 16 lettuce and 6 lamb's lettuce varieties and to evaluate colour parameters and relative chlorophyll content in the leaves. Three cultivation periods were compared, i.e. for the lettuce: spring term in a greenhouse and outdoors and autumn term in a greenhouse, and for lamb's lettuce: spring term in a greenhouse and outdoors and autumn term outdoors. Chroma meter was used for measurements of colour parameters *L**, *a** and *b**, and SPAD chlorophyll meter for relative chlorophyll content. The lettuce and lamb's lettuce from spring cultivation in the greenhouse had significantly higher values of parameter *Chroma* (*C**). The relative chlorophyll content was highly correlated with colour parameters. The same variety of lettuce or lamb's lettuce grown outdoors contained higher relative chlorophyll content in the leaves like those produced in the greenhouse. Varieties with higher relative chlorophyll content were also visually darker green in colour.

Key words: chlorophyll; cultivation period; colour parameters; lettuce; lamb's lettuce

Introduction

Lettuce (*Lactuca sativa* L.) and lamb's lettuce (*Valeriana locusta* L.) are economically important fresh salad vegetables worldwide which have become available to consumers throughout the whole year in the last decade (Mampholo et al., 2016; Nicolle et al., 2004). In Slovenia, they are common leafy vegetables both in gardens and market production. In 2017

lettuce was cultivated on 738 ha and lamb's lettuce on 85 ha (SI-STAT, 2019). In 2018 fourteen local lettuce and three lamb's lettuce varieties were registered in national variety catalogue (National List of Varieties, 2018). Local varieties are less represented in market production, mainly due to lower yields and higher sensitivity to some diseases, while they prevail in the hobby gardens. Colour is one of the most important traits for consumers, playing a crucial role in choice making, preference and acceptability of the product, including lettuce and lamb's lettuce (Colonna et al., 2016). The colour preference is subjective; however, consumers associate the colour of vegetables with freshness (Lee et al., 2013). Colour is an important parameter of the quality of vegetables, which depends on chemical, biochemical, microbiological and physical changes that occur during growth, maturation, post-harvest handling and processing (Pathare et al., 2013). The colour can be described by different colour coordinate systems, among which are the most commonly used *L**, *a** and *b** parameters (CIE, Commission Internationale de I'Eclairage's) (Marković et al., 2013). According to the CIE concepts, the human eye has three colour receptors, i.e. red, green and blue, and all colours are a combination of them. CIE *L*a*b** was created in 1976 and provides more uniform colour differences compared to human perceptions of differences. Parameters *L**, *a**, *b** describe a three-dimensional colour space in which *L** describes the brightness of the colour from 0 (completely black) to 100 (completely white), *a** describes the position between red (positive values [+60]) and green (negative values [-60]), and *b** position between yellow (positive values [+60]) and blue (negative values [-60]). *Chroma* (*C**) represents colour saturation which varies from dull (low value) to vivid colour (high value) and is calculated using the following formula $(a^2+b^2)^{1/2}$. *Hue angle* (*h**) is used to define the difference of a certain colour with reference to grey colour with the same lightness and is calculated as $\tan^{-1}(b^*/a^*)$ (Pathare et al., 2013).

Chlorophyll is a pigment that gives plants their green colour. The pigments play important physiological functions, such as photosynthetic processes and light stress defence, but they also benefit human health because of their antioxidant action and anti-carcinogenic properties (Steidle Neto et al., 2017). The postharvest life of leafy vegetable such as lettuce and lamb's lettuce is quite short because of water loss, chlorophyll losses and decay during the market conditions. Chlorophyll content decreases to half during the initial days after harvest and even faster under dark storage conditions (Kasim and Kasim, 2017).

The aim of the present study was to compare colour parameters and relative chlorophyll content in the leaves of several local lettuce and lamb's lettuce varieties grown at different cultivation periods. The obtained data will be objective support for a visual assessment of the colour.

Material and Methods

All experiments were carried out at the fields (304 m a.s.l.; 46.151°N 14.562°E) of the Infrastructure Centre Jablje at Agricultural Institute of Slovenia in 2017. Each experiment was designed as a randomised block in three replicates. Sixteen lettuce ('Vegorka', 'Bistra', 'Mima', 'Unicum', 'Leda', 'Ljubljanska ledenka', 'Belokriška', 'Pavlinčica', 'Posavka', 'Dalmatinska ledenka', 'Marija', 'Trnovska ledenka', 'Šempetrka', 'Anna', selection '8/1/7 KIS15', selection '15/1/4 KIS15') and six lamb's lettuce varieties ('Ljubljanski', 'Žličar', 'Pomladin', 'D'Olanda', 'Verte de Cambrai', 'Gala') were evaluated. Three cultivation periods were compared, i.e. for lettuce: spring term in a greenhouse (1) and outdoors (2) and autumn term in a greenhouse (3); and for lamb's lettuce: spring term in a greenhouse (1) and outdoors (2) and autumn term outdoors (3). Lettuce seedlings were raised in polystyrene growing plates with 104 cells in a heated greenhouse. Seeding for spring term was carried out on 1th of February, transplanting of seedlings in a greenhouse on 16th of March and in open field on 21th of March and measurements at the technological maturity before harvesting on 21th of April in a greenhouse and on 19th of May in the open field. Seeding for the autumn term was carried out on 24th of July, transplanting of seedlings in a greenhouse on 18th of August and measurements performed at the technological maturity on 4th of October. Seedlings were planted in three-row beds at a distance 30 cm × 30 cm with the plot size 2.7 m^2. Direct sowing of lambs' lettuce for spring term was carried out on 10th of March in a greenhouse and on 21th of March in the open field and for autumn term on 18th of August in the open field and measurements performed at the technological maturity on 21th of April, 19th of May and 16th of November. Lamb's lettuce was sown directly in five-row beds at a distance of 15 cm between the rows. When the plants had two true leaves they were thinned to the distance of 3 cm within the row. The plot size was 1.5 m^2. The experiments were fertilized in accordance with soil fertility and expected yields. Colour of lettuce and lamb's lettuce leaves was measured using portable Chroma meter (Minolta CR-400, Kyoto, Japan). The measuring aperture diameter was 8 mm, and the instrument was calibrated with a Minolta standard white plate before sampling the leaves. Fifteen leaves per experimental unit (each variety in three repetitions) were randomly measured in each of the terms. Individual readings were taken on the upper surface of randomly selected leaves in the middle between the apical and basal end. C^* and h^* values were calculated from parameters L^*, a^* and b^*. The results are shown as the mean values of all measurements for individual variety within each of the terms (n=45). A chlorophyll meter SPAD-502Plus

(Konica-Minolta, Osaka, Japan) was used to take readings from fully expanded leaves. Fifteen leaves per experimental unit (each variety in three repetitions) were randomly measured in each of the terms and averaged to a single SPAD value. The results are given as the mean of averaged values for each variety in each term (n=3). The results were statistically evaluated using the Statgraphics Centurion XVI (Statgraphics Centurion, 2009). The statistical significance of the effect of each factor (variety and cultivation period) was determined by two-factor ANOVA and the differences among the mean values of each of the factors calculated by Duncan's multiple range test. All tests were performed and compared at 5 % confidence level ($P < 0.05$).

Results and Discussion

The lettuce and lamb's lettuce quality is determined by the characteristics relevant to marketing, among which the external look or appearance is crucial. With this purpose, the colour of different local varieties of lettuce and lamb's lettuce were evaluated. Colour parameters CIELAB and SPAD index, i.e. the relative chlorophyll content, differed significantly between the varieties of both species and between different cultivation periods. Tab. 1 shows data of colour parameters *L**, *a**, *b**, *C**, *h** and relative chlorophyll contents for sixteen lettuce varieties grown at three cultivation periods, while Tab. 2 summarises the results of the statistical analysis of differences between the varieties and between the cultivation periods. Parameter *L** (colour lightness) was, regardless of the cultivation period, significantly the highest for variety 'Ljubljanska ledenka'. Parameter *a** (position between red and green) had significantly the highest negative value for 'Unicum' and parameter *b** (position between yellow and blue) significantly the highest positive value for 'Belokriška'. The comparison of the cultivation periods showed that parameters *L** and *b** were significantly the highest in the spring term in a greenhouse (1) and *a** (negative value) in the autumn term in a greenhouse (3). For parameter *C** the highest value was determined for the variety 'Belokriška' (34.83), while the lowest for 'Mima' (27.52). Parameter *C** was, regardless of variety, the highest in cultivation period 1, i.e. spring term in a greenhouse (32.90), and the lowest in cultivation period 2, i.e. spring term outdoor (31.90). The highest *h** value was determined for the variety 'Belokriška' (65.78), while the lowest for 'Mima' (59.21). For all lettuce varieties (except 'Anna') was parameter *h** the highest in cultivation period 1, i.e. spring term in a greenhouse.
The relative chlorophyll content was, regardless of cultivation period, significantly the highest for varieties 'Posavka', 'Dalmatinska ledenka', 'Šempetrka' and '15/1/4 KIS15', and significantly the lowest for 'Ljubljanska ledenka', 'Vegorka', 'Belokriška' and 'Unicum'. Comparing the

cultivation periods, the relative chlorophyll content in lettuce leaves was significantly the highest in cultivation period 2, i.e. spring term outdoor, while there was no difference between the both cultivation periods in a greenhouse (1 and 3).

Table 1. Colour parameters and relative chlorophyll content of sixteen lettuce varieties grown at three cultivation periods

Variety	Cultivation period	*L**	*a**	*b**	*C**	*h**	Relative chlorophyll content
Posavka	1	44.77 ±3.52	-14.45 ±1.35	24.86 ±2.13	28.77 ±2.38	59.82 ±1.65	31.40 ±0.88
	2	45.02 ±3.27	-13.43 ±1.18	24.33 ±2.09	27.82 ±1.95	61.02 ±2.89	34.00 ±0.73
	3	44.48 ±3.34	-14.88 ±0.90	24.47 ±2.16	28.65 ±2.15	58.61 ±1.83	33.13 ±1.27
Vegorka	1	50.09 ±4.29	-13.94 ±1.69	29.96 ±2.59	33.07 ±2.82	65.05 ±2.18	16.60 ±1.04
	2	47.31 ±3.83	-12.43 ±1.83	28.11 ±2.55	30.78 ±2.64	66.13 ±3.11	19.30 ±0.22
	3	49.10 ±2.79	-14.77 ±1.13	28.47 ±1.83	32.09 ±1.94	62.56 ±1.66	17.93 ±0.21
Unicum	1	/	/	/	/	/	/
	2	/	/	/	/	/	/
	3	50.13 ±2.50	-15.05 ±1.14	29.90 ±1.86	33.49 ±2.00	63.27 ±1.48	18.20 ±0.62
Dalmatinska ledenka	1	43.68 ±4.14	-14.47 ±1.26	25.41 ±2.28	29.27 ±2.31	60.27 ±2.36	29.57 ±1.18
	2	45.31 ±3.55	-13.05 ±0.93	24.88 ±2.03	28.12 ±1.92	62.24 ±2.36	34.47 ±1.72
	3	44.98 ±3.06	-14.47 ±0.91	24.54 ±1.90	28.50 ±1.90	59.42 ±1.84	30.00 ±0.59
Ljubljanska ledenka	1	52.30 ±3.79	-13.87 ±1.36	30.27 ±2.39	33.31 ±2.54	65.37 ±1.84	15.83 ±1.60
	2	52.50 ±3.98	-11.82 ±1.41	29.15 ±2.34	31.47 ±2.51	67.94 ±1.97	17.80 ±0.54
	3	51.06 ±3.09	-14.56 ±1.06	29.27 ±1.89	32.70 ±2.02	63.54 ±1.35	17.10 ±0.43
Leda	1	51.67 ±4.33	-14.89 ±1.33	31.12 ±2.86	34.51 ±3.01	64.40 ±1.57	18.33 ±0.31
	2	49.64 ±3.99	-13.27 ±1.33	29.80 ±2.71	32.65 ±2.73	65.94 ±2.24	23.20 ±0.88
	3	47.91 ±3.56	-14.25 ±1.67	27.76 ±2.88	31.22 ±3.17	62.82 ±1.88	17.23 ±0.49
Pavlinčica	1	51.03 ±4.68	-14.03 ±1.54	29.20 ±2.56	32.41 ±2.79	64.34 ±1.85	21.33 ±0.59
	2	47.59 ±4.21	-13.01 ±1.43	27.49 ±2.18	30.43 ±2.37	64.67 ±2.07	27.47 ±0.57
	3	45.53 ±4.91	-14.60 ±1.43	27.19 ±2.63	30.87 ±2.91	61.75 ±1.36	19.63 ±0.94
Marija	1	49.04 ±4.42	-14.79 ±1.24	32.25 ±2.09	35.51 ±2.09	65.33 ±1.99	18.37 ±0.76
	2	50.61 ±4.40	-13.25 ±1.76	30.43 ±2.80	33.22 ±2.95	66.46 ±2.56	22.30 ±0.43
	3	50.73 ±3.48	-15.07 ±1.19	31.21 ±2.13	34.68 ±2.15	64.20 ±1.96	17.23 ±0.90
Šempetrka	1	44.68 ±3.51	-15.17 ±1.03	26.00 ±2.01	30.12 ±2.04	59.69 ±1.84	29.07 ±0.97
	2	44.72 ±4.70	-13.30 ±1.30	25.20 ±1.97	28.53 ±1.97	62.14 ±2.63	32.47 ±0.90
	3	45.02 ±3.42	-14.83 ±0.94	25.11 ±1.97	29.18 ±1.87	59.36 ±2.21	25.87 ±0.17
Belokriška	1	51.50 ±3.94	-14.28 ±1.29	31.95 ±2.79	35.01 ±2.87	65.86 ±1.82	18.40 ±0.45
	2	50.02 ±3.89	-13.38 ±1.51	32.50 ±2.78	35.19 ±2.62	67.53 ±2.89	18.57 ±0.17
	3	50.17 ±2.82	-15.05 ±1.10	30.85 ±1.88	34.34 ±1.89	63.98 ±1.81	18.00 ±0.67
Anna	1	50.44 ±4.19	-14.83 ±1.35	31.74 ±2.33	35.05 ±2.47	64.95 ±1.72	18.60 ±0.99
	2	46.42 ±4.38	-13.89 ±1.53	29.24 ±2.33	32.39 ±2.56	64.62 ±1.95	21.80 ±1.48
	3	45.86 ±3.81	-14.35 ±1.21	28.01 ±2.03	31.48 ±2.16	62.86 ±1.76	17.30 ±0.24
Bistra	1	48.88 ±3.63	-15.24 ±1.49	31.74 ±2.05	35.23 ±2.18	64.34 ±2.09	22.97 ±0.17
	2	48.19 ±3.70	-13.06 ±1.31	29.13 ±2.32	31.95 ±2.21	65.78 ±2.67	27.33 ±1.02
	3	48.90 ±2.94	-14.84 ±1.11	29.01 ±2.05	32.60 ±2.14	62.89 ±1.63	22.04 ±2.51
Trnovska ledenka	1	51.64 ±4.05	-14.65 ±1.38	32.07 ±2.43	35.27 ±2.64	65.45 ±1.48	20.60 ±0.73
	2	51.12 ±4.51	-12.90 ±1.37	31.18 ±2.58	33.77 ±2.65	67.49 ±2.10	22.93 ±0.85
	3	49.62 ±2.83	-15.25 ±1.05	30.21 ±1.92	33.86 ±1.84	63.17 ±2.00	18.63 ±0.87
8/1/7 KIS15	1	51.42 ±2.79	-14.47 ±1.29	31.32 ±2.04	34.52 ±2.19	65.20 ±1.72	20.83 ±0.54
	2	49.26 ±3.05	-13.71 ±1.38	29.67 ±1.99	32.71 ±2.06	65.18 ±2.25	28.17 ±0.98
	3	50.69 ±2.82	-14.96 ±1.43	29.70 ±2.46	33.27 ±2.71	63.26 ±1.49	17.40 ±0.24
15/1/4 KIS15	1	44.72 ±3.24	-14.32 ±1.24	26.10 ±1.88	29.78 ±2.11	61.26 ±1.48	27.93 ±0.90
	2	43.88 ±3.43	-13.61 ±1.33	25.61 ±2.06	29.02 ±2.25	62.01 ±1.95	30.77 ±0.97
	3	43.02 ±3.55	-14.04 ±1.17	23.25 ±2.02	27.17 ±2.22	58.84 ±1.54	27.78 ±1.60
Mima	1	43.80 ±2.92	-14.36 ±1.09	25.11 ±1.89	28.94 ±2.07	60.22 ±1.36	23.80 ±0.36
	2	41.66 ±3.17	-13.03 ±1.24	22.90 ±2.28	26.37 ±2.30	60.29 ±2.59	26.77 ±0.66
	3	41.48 ±3.21	-14.76 ±0.79	22.88 ±2.05	27.24 ±1.96	57.07 ±2.13	29.27 ±0.53

Data are means ±standard deviation (n=45).

Table 2. Summary statistics for lettuce colour parameters and chlorophyll content

Parameter	*L**	*a**	*b**	*C**	*h**	Relative chlorophyll content
Mean across variety						
Posavka	44.80 b	-14.26 abc	24.59 b	28.45 b	59.83 b	32.84 i
Vegorka	48.81 d	-13.72 ef	28.84 e	31.98 e	64.57 ef	17.94 ab
Unicum	50.71 e	-14.46 a	30.67 gh	33.91 hi	63.89 fg	18.67 ab
Dalmatinska ledenka	44.63 b	-13.99 cde	24.93 bc	28.62 b	60.63 c	31.34 i
Ljubljanska ledenka	51.99 f	-13.40 f	29.57 f	32.50 ef	65.65 h	16.91 a
Leda	49.81 e	-14.16 abcd	29.59 f	32.83 fg	64.37 ef	19.59 bc
Pavlinčica	48.34 cd	-13.86 de	27.97 d	31.23 d	63.64 d	22.64 ef
Marija	50.19 e	-14.36 abc	31.27 hi	34.44 ij	65.32 gh	19.24 bc
Šempetrka	44.82 b	-14.43 ab	25.44 c	29.28 c	60.41 c	29.13 h
Belokriška	50.57 e	-14.24 abcd	31.75 i	34.83 j	65.78 h	18.32 ab
Anna	47.75 c	-14.37 abc	29.76 f	33.07 fg	64.18 e	19.23 bc
Bistra	48.56 cd	-14.41 ab	30.00 f	33.31 gh	64.32 ef	24.00 f
Trnovska ledenka	50.87 e	-14.22 abcd	31.18 hi	34.30 ij	65.45 h	20.65 cd
8/1/7 KIS15	50.41 e	-14.39 abc	30.22 fg	33.49 gh	64.51 ef	22.13 de
15/1/4 KIS15	43.88 b	-13.99 cde	25.00 bc	28.67 bc	60.72 c	28.87 h
Mima	42.33 a	-14.05 bcde	23.64 a	27.52 a	59.21 a	26.61 g
Mean across cultivation period						
1	48.89 B	-14.55 B	29.46 C	32.90 C	63.56 B	22.02 A
2	47.75 A	-13.15 C	28.11 B	31.09 A	64.74 C	25.60 B
3	47.45 A	-14.74 A	27.63 A	31.35 B	61.72 A	21.60 A

Mean values with different lowercase letters (a,b, …) in columns are significantly different (P <0.05; differences between varieties); mean values with different capital letters (A,B,C) in columns are significantly different (P <0.05; differences between cultivation periods).

Tab. 3 shows data of colour parameters and relative chlorophyll contents for six lamb's lettuce varieties grown at three cultivation periods, while Tab. 4 summarises the results of the statistical analysis of differences between the varieties and between the cultivation periods. Parameters *L**, *a** (negative value) and *b** were, regardless of cultivation period, significantly the highest for the variety 'Pomladin'. At comparing the cultivation periods, parameters *L**, *a** (negative value) and *b** were significantly the highest in cultivation period 1, i.e. spring term in a greenhouse. The highest *C** value was determined for the variety 'Pomladin' (35.20) and the lowest for 'Verte de Cambrai' (20.11). Parameter *C** was, regardless of variety, the highest in cultivation period 1, i.e. spring term in a greenhouse (28.95) and the lowest in cultivation period 3, i.e. autumn term outdoor (22.86). The highest *h** value was determined for the variety 'Pomladin' (63.71) and the lowest for 'Verte de Cambrai' (50.88). For all varieties of lamb's lettuce the parameters *h** and *C** were the highest in cultivation period 1, i.e. spring term in a greenhouse.

Relative chlorophyll content was regardless of the cultivation period significantly the highest for varieties 'Verte de Cambrai' and 'Gala' and the lowest for 'Pomladin'. At comparing the cultivation periods, the relative chlorophyll content in lamb's lettuce leaves was significantly the highest in cultivation period 3, i.e. autumn term outdoor, and the lowest in cultivation period

1, i.e. spring term in a greenhouse. The relative chlorophyll content of lamb's lettuce was in high negative correlation with the parameters *C** (-0.919), *b** (-0.916) and *h** (-0.838).

Table 3. Colour parameters and relative chlorophyll content of six lamb's lettuce varieties grown at three cultivation periods

Variety	Cultivation period	*L**	*a**	*b**	*C**	*h**	Relative chlorophyll content
Ljubljanski	1	42,51 ±3,88	-15,45 ±1,14	24,82 ±1,98	29,24 ±2,18	58,07 ±1,34	28,70 ±0,78
	2	43,08 ±3,24	-13,80 ±1,31	21,70 ±2,14	25,74 ±2,23	57,47 ±2,53	39,30 ±0,80
	3	39,82 ±2,81	-13,88 ±0,98	17,66 ±1,71	22,47 ±1,86	51,76 ±1,71	49,33 ±0,33
Žličar	1	40,50 ±3,97	-14,57 ±1,23	24,26 ±2,16	28,31 ±2,36	58,98 ±1,58	30,53 ±1,16
	2	42,51 ±3,14	-13,53 ±1,29	20,24 ±1,45	24,36 ±1,76	56,28 ±1,88	38,97 ±1,27
	3	38,96 ±4,15	-13,51 ±0,92	16,93 ±1,47	21,67 ±1,67	51,36 ±1,21	46,73 ±0,54
Pomladin	1	51,28 ±2,14	-15,46 ±1,11	34,30 ±1,63	37,63 ±1,70	65,73 ±1,50	20,17 ±0,41
	2	47,10 ±4,40	-15,22 ±1,49	30,54 ±2,49	34,16 ±2,41	63,46 ±2,72	28,27 ±0,76
	3	50,49 ±4,17	-15,93 ±1,27	29,61 ±1,92	33,63 ±2,17	61,73 ±1,29	25,63 ±0,62
Gala	1	41,30 ±3,25	-14,20 ±1,09	20,50 ±2,06	24,95 ±2,23	55,22 ±1,57	38,47 ±0,39
	2	41,88 ±2,60	-12,45 ±1,16	17,03 ±2,11	21,12 ±2,15	53,72 ±2,87	49,10 ±1,07
	3	38,96 ±2,87	-12,29 ±1,19	14,15 ±1,49	18,74 ±1,84	48,99 ±1,60	53,17 ±1,84
D'Olanda	1	43,43 ±3,32	-15,29 ±1,11	24,21 ±1,87	28,64 ±2,07	57,71 ±1,34	31,13 ±0,92
	2	42,22 ±2,93	-13,55 ±1,25	20,61 ±1,92	24,68 ±2,06	56,64 ±2,28	43,60 ±0,64
	3	39,50 ±2,38	-14,27 ±0,77	18,25 ±1,20	23,17 ±1,38	51,96 ±0,91	48,27 ±0,45
Verte de Cambrai	1	42,14 ±2,85	-14,50 ±0,99	20,21 ±1,83	24,88 ±1,92	54,26 ±1,82	38,37 ±2,44
	2	40,38 ±2,00	-11,30 ±1,19	14,14 ±1,42	18,12 ±1,66	51,35 ±2,57	50,27 ±0,60
	3	39,21 ±2,38	-11,88 ±0,71	12,81 ±1,14	17,47 ±1,25	47,10 ±1,60	52,23 ±3,21

Data are means ±standard deviation (n=45).

Table 4. Summary statistics for lamb's lettuce colour parameters and chlorophyll content

Parameter	*L**	*a**	*b**	*C**	*h**	Relative chlorophyll content
Mean across variety						
Ljubljanski	41,81 c	-14,36 b	21,37 d	25,79 d	55,78 c	39,11 b
Žličar	40,84 abc	-13,91 c	20,46 c	24,79 c	55,46 c	38,74 b
Pomladin	49,71 d	-15,58 a	31,54 e	35,20 e	63,71 c	24,69 a
Gala	40,72 ab	-12,96 d	17,23 b	21,60 b	52,64 b	46,91 c
D'Olanda	41,67 bc	-14,36 b	21,05 d	25,51 d	55,48 c	41,00 b
Verte de Cambrai	40,55 a	-12,53 e	15,68 a	20,11 a	50,88 a	46,96 c
Mean across cultivation period						
1	43,58 B	-14,93 A	24,72 C	28,95 C	58,31 C	31,23 A
2	42,91 B	-13,30 C	20,72 B	24,70 B	56,50 B	41,58 B
3	41,16 A	-13,62 B	18,23 A	22,86 A	52,15 A	45,89 C

Mean values with different lowercase letters (a,b, …) in columns are significantly different ($P < 0.05$; differences between varieties); mean values with different capital letters (A,B,C) in columns are significantly different ($P < 0.05$; differences between cultivation periods).

Conclusion

The cultivation period, i.e. term, had a significant effect on the colour parameters of lettuce and lamb's lettuce. The lettuce and lamb's lettuce had a significantly higher *Chroma* (*C**) value for spring cultivation period in a greenhouse. The relative chlorophyll content was highly

correlated with the colour parameters for lamb's lettuce. Lettuce and lamb's lettuce (regardless the variety) grown in the open field contained a significantly higher relative chlorophyll content in the leaves compared to the production in a greenhouse.

Acknowledgements

This research was a part of the Target Research Project V4-1618 titled "Genetic erosion threats to local varieties and their value for production and use" (contract No. 2330-16-000188) and of the expert task Special testing varieties for the descriptive catalogue of varieties (contract No. 2330-17-000111).

References

Colonna E., Rouphael Y., Barbieri G. & De Pascale S. (2016). Nutritional quality of ten leafy vegetables harvested at two light intensities. *Food chemistry*, 199, 702–710.

Lee S. M., Lee K. T., Lee S. H. & Song J. K. (2013). Origin of human colour preference for food. *Journal of Food Engineering*, *119(3)*, 508–515.

Kasim M. U. & Kasim R. (2017). While continuous white LED lighting increases chlorophyll content (SPAD), green LED light reduces the infection rate of lettuce during storage and shelf-life conditions. *Journal of food processing and preservation*, 41(6), 1–7.

Mampholo B. M., Maboko M. M., Soundy P. & Sivakumar D. (2016). Phytochemicals and overall quality of leafy lettuce (*Lactuca sativa* L.) varieties grown in closed hydroponic system. *Journal of Food Quality*, 39(6), 805–815.

Marković I., Ilic J., Marković D., Simonović V. & Kosanić N. (2013). Color measurement of food products using CIE L*a*b* and RGB color space. *Journal of Hygienic Engineering and Design*, 4, 50–53.

National List of Varieties (2018). Ministry of agriculture, forestry and food, Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection.
http://www.uvhvvr.gov.si/fileadmin/uvhvvr.gov.si/pageuploads/OBJAVE_ZA_JAVNOST/Objave_SEME/Sortna_lista/SL_2018_splet.pdf

Nicolle C., Carnat A., Fraisse D., Lamaison J. L., Rock E., Michel H., Amouroux P. & Remesy C. (2004). Characterisation and variation of antioxidant micronutrients in lettuce (*Lactuca sativa* folium). *Journal of the Science of Food and Agriculture*, 84(15), 2061–2069.

Pathare, P. B., Opara, U. L. & Al-Said, F.A. J. (2013). Colour measurement and analysis in fresh and processed foods: a review. *Food and Bioprocess Technology*, 6(1), 36–60.

SI-STAT (2019). SURS. Production of vegetables (ha, t, t/ha), Slovenia, annually. https://pxweb.stat.si/pxweb/Dialog/varval.asp?ma=1502403E&ti=&path=../Database/Environment/15_agriculture_fishing/04_crop_production/01_15024_crops_area/&lang=1.

Steidle Neto, A.J., Moura, L.D.O., Lopes, D.D.C., Carlos, L.D.A., Martins, L.M. & Ferraz, L.D.C.L. (2017). Non-destructive prediction of pigment content in lettuce based on visible–NIR spectroscopy. *Journal of the Science of Food and Agriculture*, 97(7), 2015–2022.

Utjecaj perioda uzgoja različitih sorti *Lactuca sativa* L. i *Valeriana locusta* L. na parametre boje i sadržaj klorofila

Lovro Sinkovič[1], Mojca Škof[1], Kristina Ugrinović[1]

[1]*Crop Science Department, Agricultural Institute of Slovenia, Ljubljana, Slovenia*

Corresponding author: Lovro Sinkovič, lovro.sinkovic@kis.si

Sažetak

Salata i matovilac su popularno sveže povrće za salatu koje je potrošačima na raspolaganju tokom cele godine. Cilj istraživanja je bio, da se usporede tri perioda uzgoja 16 sorti salata i 6 sorti matovilaca i da se procene parametri boje i relativni sadržaj hlorofila. Upoređena su tri perioda uzgoja, tj. za salatu: proljetni termin u plasteniku i na otvorenom i jesenski termin u plasteniku, te za matovilac: proljetni termin u plasteniku i na otvorenom i jesenski termin na otvorenom. Croma metar bio je korišćen za merenje parametara boje *L**, *a** i *b** i SPAD metar za relativni sadržaj hlorofila. Salata i motovilac od proljetne uzgoje u plasteniku imali su značajno veće vrijednosti parametra *Chroma* (*C**). Relativni sadržaj hlorofila bio je u visokoj korelaciji sa parametrima boje. Ista sorta salate ili motovilaca koja se uzgajala na otvorenom imala je veći sadržaj hlorofila u listovima kao ona proizvedena u plasteniku. Sorte sa višim relativnim sadržajem hlorofila su takođe vizuelno tamnije zelene boje.

Ključne riječi: hlorofil; period uzgoja; parametri boja; salata; matovilac

Original scientific paper

Properties of grapevine hybrid '14362' obtained from crossing combination Red Traminer × Early Muscat

Zorica Ranković-Vasić, Aleksandar Petrović, Nikolina Lisov, Saša Matijašević, Mirjam Vujadinović Mandić, Ana Vuković, Sara Muždalo, Dragan Nikolić

University of Belgrade, Faculty of Agriculture, Belgrade, Serbia

Corresponding author: Zorica Ranković-Vasić, zoricarv@agrif.bg.ac.rs

Abstract

The most important method for creating new grapevine varieties is hybridization. Work on the creation of new grape varieties by hybridization has been in progress for a long time on the Faculty of Agriculture University in Belgrade. This paper presents the results obtained from two years research (2017-2018) of important properties of perspective hybrid intended for table and wine production. The properties of studied hybrid were compared to the parental partners Red Traminer and Early Muscat. Data analysis was performed using the statistical software package Statistica, Version 8 (StatSoft, Inc., Tulsa, Oklahoma, USA). The results of the study showed that the hybrid 14362 had a higher grape yield (2.25 kg per vine) than the Red Traminer (1.80 kg per vine), while the Early Muscat had a grape yield of 3.44 kg per vine. The hybrid 14362 had a higher bunch weight (258.0 g) than the Red Traminer (118.6 g), and a smaller bunch weight compared to the Early Muscat (302.0 g). Hybrid 14362 and Red Traminer had approximately the same sugar content (22.6; 22.9%) and total acid content in the must (7.1; 7.2 g/l). Sugar and total acid content were lower in Early Muscat (18.1%; 6.9 g/l). The investigated hybrid 14362 due to its specificity and diversity in relation to parental partners should be further monitored and studied in order to obtain a more detailed analysis of the most important traits.

Key words: grapevine, hybridization, yield, quality

Introduction

Grapevine (*Vitis vinifera* L.) is one of the most important horticultural plants with a worldwide distribution (Catacchio, 2019). Its fruits are processed into products such as wine and juice or consumed as fresh table grapes or raisins (Zyprian et al., 2018). The number of used cultivars is very large. The approximate number of different varieties held in germplasm collections worldwide is 10 000 (This et al., 2006). Usually every region possesses its specific grape varieties, selected over the centuries, which gave rise to typical regional products (Camargo and Ritschel, 2008). In the grapevine breeding programs, it is necessary to determine the goal of breeding and application of the appropriate method for achieving this goal. Agronomical traits are wery important for the grapevine growers while flavour and quality of grapes is required by consumers (Regner, 2002). Hybridization is the most important and the most widespread method for creating new varieties. Recognized varieties are placed on the sort list, which is the beginning of their introduction into production (Nikolić et al., 2009). The aim of this study was to investigate the economic and technological characteristics of perspective hybrid (14362) in agroecological conditions of Grocka vineyard, in relation to the grapevine varieties Red Traminer and Early Muscat as parental partners.

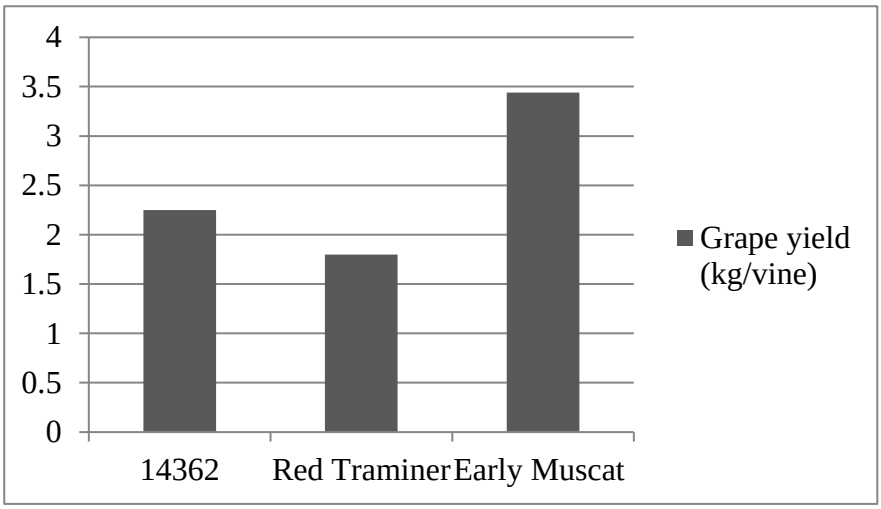
Material and Methods

The investigations were done at Experimental Field (E.F.) "Radmilovac" of the Faculty of Agriculture, University of Belgrade during 2017 and 2018. Based on the viticultural zoning from 2015, E.F. "Radmilovac" belongs to the Belgrade region, Grocka vineyards, which is located in a hilly area on the right bank of the Danube, downstream of Belgrade. As the material in this research the: perspective grapevine hybrid 14362 and varieties Red Traminer and Early Muscat were used. Hybrid 14362 was obtained by crossing the grapevine varieties Red Traminer and Early Muscat. The hybrid is intended for table and wine production (combined properties), and belongs to the early maturing group of vine varieties. The hybrid and parental varieties were grafted on *V. berlandieri* x *V. riparia* Kober 5BB rootstock and planted at a distance of 3.0 x 1.0 m. The training system was double Guyot. All the properties of this hybrid were compared to parental partners. The following parameters were tested: grape yield (kg per vine); the bunch properties: weight (g), length (cm), width (cm) and number of berries in bunch; characteristics of berries: weight (g), length (mm) and width (mm); indicators of grape quality:

sugar content in the must (%) and total acid content in the must (g/l). Grape yield was determined at the moment of harvesting, measuring the weight of all bunches per vine. The digital scale of the "CAS-Shollex type SHRE-122" and the analytical balance "Tecator-6110 BALLANCE" were used for the weight measurement of grapes, bunches and berries. Sugar content was determined using the digital refractometer (PocketPAL - 1, Atago, Japan). The total acid content in the must was determined by the method of titration with n/4 NaOH. Statistical analysis was done by the method of analysis of variance (ANOVA), and individual testing of differences between hybrid and standard varieties was performed using the Dunnett test for the significance level $P < 0.05$ and $P < 0.01$. Data analysis was performed using the statistical software package Statistica, Version 8 (StatSoft, Inc., Tulsa, Oklahoma, USA).

Results and Discussion

The results of the study showed that the hybrid 14362 had a higher grape yield (2.25 kg per vine) than the Red Traminer (1.80 kg per vine), while the Early Muscat had a grape yield of 3.44 kg per vine (Graph 1). According to the Van Leeuwen et al. (2018), yield parameters were equally impacted by the soil and the climate. Nikolić et al. (2017), in their research of different grapevine hybrids, showed significant differences between genotypes, localities and their interaction of bunch and berry properties. On the basis of the total number of vines per unit area and the average yield of grape per vine, it was found that the highest yield per hectare had the hybrid 9896 (14998 kg).



Graph 1. Grape yield (kg per vine) of investigated hybrid and parental partners (2017-2018 years)

The hybrid 14362 had a higher bunch weight (258.0 g) than the Red Traminer (118.6 g), and a smaller bunch weight compared to the Early Muscat (302.0 g). The Red Traminer and Early Muscat had a bunch length of 10.6 and 18.4 cm, while hybrid 14362 had a length of 13.8 cm. The largest bunch width had a hybrid 14362 (11.56 cm). The hybrid 14362 had a significantly higher number of berries (123.0) in the bunch (Tab. 1) compared to their parents (84.0 and 82.4 respectively).

Table 1. The bunch properties (2017-2018 years)

Hybrid/Standard variety	Bunch weight (g)	Bunch length (cm)	Bunch width (cm)	Number of berries in the bunch
14362	258.0	13.8	11.56	123.0
Red Traminer	118.6**	10.6**	6.9**	84.0**
Early Muscat	302.0	18.4**	10.8	82.4**
D 0.05	67.70	2.21	1.87	24.09
D 0.01	96.59	3.16	2.67	34.37

** p<0.01 Stars at mean values show the significance difference of hybrid 14362 compared to standards.

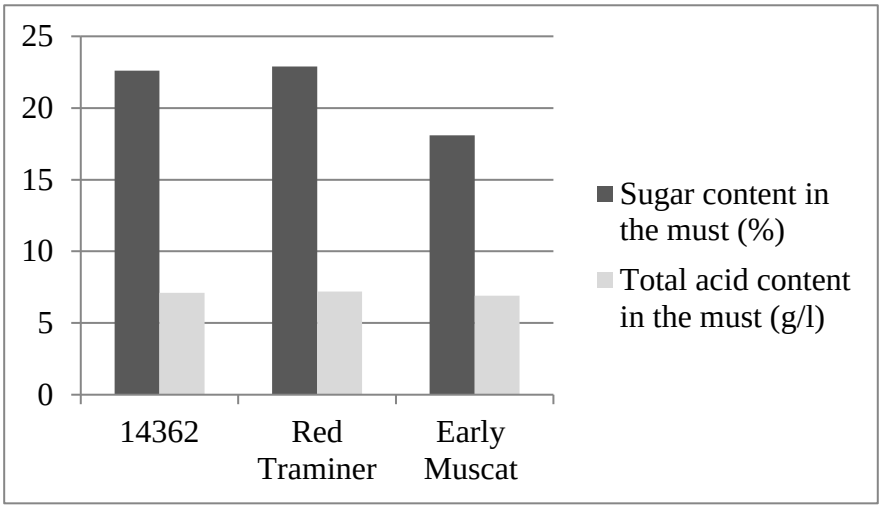
Significant differences between grapevine hybrid 14362 and Early Muscat were determined for berry characteristics (Tab. 2). The investigated hybrid 14362 had the lowest average berries weight (1.92 g), while the length and width of the berries were higher than the Red Traminer and less than the Early Muscat grapevine variety.

Table 2. The berry properties (2017-2018 years)

Hybrid/Standard variety	Berry weight (g)	Berry length (mm)	Berry width (mm)
14362	1.92	16.79	14.79
Red Traminer	2.36	16.45	14.63
Early Muscat	3.64**	19.37**	19.01**
D 0.05	0.464	1.02	1.21
D 0.01	0.662	1.46	1.73

** p<0.01 Stars at mean values show the significance difference of hybrid 14362 compared to standards.

Hybrid 14362 and Red Traminer had approximately the same sugar content (22.6; 22.9%) and total acid content in the must (7.1; 7.2 g/l). Sugar and total acid content were lower in Early Muscat (18.1%; 6.9 g/l).



Graph 2. Indicators of grape quality (2017-2018 years)

Flavor composition has been defined as a complex attribute of fruit quality, in which the mix of sugars, acids and volatiles play a primary role. In table grapes (*Vitis vinifera* L.), sweetness and sourness are the most important flavor attributes for fresh consumption. However, most of the studies available have been performed on wine grapes, which are grown, cultured and processed differently to table grapes (Muñoz-Robredo et al., 2011). Among the cultivars of *V. vinifera*, wine grapes were found in general to have more sugars and acids than table grapes (Liu et al., 2006). Grape yield and quality can vary from berry to berry, bunch to bunch and vine to vine basis, so variability can be expected as a result of interaction between the plant, soil and climate (Bramley and Hamilton, 2004; Bramley, 2005; Santos et al., 2008) and maturity, genotype and growing conditions (Liu et al., 2006). Significant differences in the sugar content and total acids in the must were determined Nikolić et al. (2003, 2007) and Ranković-Vasić et al. (2016) studying the quality of grapes in hybrids from different combinations of crossings.

Conclusion

The hybrid 14362 showed combined properties in agroecological conditions of Grocka vineyard. Some features were similar to table grapevine varieties, and some properties were like varieties for wine. The hybrid 14362 due to its specificity and diversity in relation to Red Traminer and Early Muscat as parental partners should be further monitored and studied in order to obtain a detailed analysis of the most important traits. The hybrid 14362 could be recommended to the Commission for the recognition of new varieties (Republic of Serbia) after

examination on other grapevine regions and localities. The combined properties (table and wine grape) as well as the early maturation period could be the benefits of this hybrid as a future grapevine variety.

Acknowledgement

This study was supported by the Ministry of Education. Science and Technological Development of the Republic of Serbia, Project TR 31063.

References

Bramley, R.G.V. & Hamilton, R.P. (2004). Understanding variability in winegrape production systems; 1. within vineyard variation in yield over several vintages. *Aust. J. Grape Wine Res.*, 10, 32-45.

Bramley, R.GV. (2005). Understanding variability in winegrape production systems; 2. within vineyard variation in quality over several vintages. *Aust J Grape Wine Res.*, 11, 33-42.

Camargo, U.A. & Ritschel, P.S. (2008). New table and wine grape cultivars: world scenario with emphasis on Brazil. *Acta Hortic.*, 785, 89-96.

Catacchio, C.R., Alagna, F., Perniola, R., Bergamini, C., Rotunno, S., Calabrese, F.M., Crupi, P., Antonacci, D., Ventura, M. & Cardone, M.F. (2019). *Transcriptomic and genomic structural variation analyses on grape cultivars reveal new insights into the genotype-dependent responses to water stress*. Scientific Reports, 9(2809), 1-15.

Liu, H.F., Wu, B.H., Fan, P.G., Li, S.H. & Li, L.S. (2006). Sugar and acid concentrations in 98 grape cultivars analyzed by principal component analysis. *Journal of the Science of Food and Agriculture*, 86, 1526-1536.

Muñoz-Robredo, P., Robledo, P., Manriquez, D., Molina, R. & Defilippi, B. (2011). Characterization of sugars and organic acids in commercial varieties of table grapes. *Chilean Journal of Agricultural Research*, 71, 452-458.

Nikolić, D., Milutinović, M., Rakonjac, V. & Fotirić, M. (2003). Characteristics of promising grapevine hybrids from different crossings. *Acta Hortic*., 603, 731-734.

Nikolić, D., Milutinović, M. & Rakonjac, V. (2007). Morphological and disease resistance characteristics of table grape hybrids. *Acta Hortic*., 760, 415-418.

Nikolić, D., Milutinović, M., Rakonjac, V. & Fotirić, M. (2009). Evaluation of resistance to low temperatures in promising interspecies grapevine hybrids. *Acta Hortic.*, 827, 461-464.

Nikolić, D., Ranković-Vasić, Z., Petrović, A., Radojević, I., Jovanović-Cvetković, T. & Sivčev, B. (2017). *Effect of genotype x environment interactions of grapevine hybrids characteristics*. BIO Web of Conferences 9. 40th World Congress of Vine and Wine, 1-5.

Ranković-Vasić, Z., Nikolić, D., Petrović, A., Sivčev, B., Kostadinović, N., Lisov, N. & Matijašević, S. (2016). Some important agrobiological and techonolgical characteriatics of promising grapevine genotypes obtained for red wine production. Annals of the University of Craiova - Agriculture, Montanology, *Cadastre Series*, Vol. XLVI/1/2016, 255-260.

Regner, F., Hack, R. & Eisenheld, C. (2004). Traditional and innovative grapevine breeding. *Bulletin O.I.V.*, 77: 885-886, 811-819.

Santos, A.O., Wample, R.L., Sachidhanantham, S., Sethuramasamyraja, B. & Kaye, O. (2008). *First attempts at instrumenting for grape quality-based harvesting procedure*. XXXVII International Conference of Agricultural Engineering: Proceddings: Contributed papers-abstracts; Oct; Foz do Iguaçú, Brasil. Foz do Iguaçú: SBEA, 20-22.

This, P., Lacombe, T. & Tomas, M. (2006). Historical origins and genetic diversity of wine grapes, *Trends Gene*t., 22, 511-519.

Van Leeuwen, C., Roby, J.P. & de Rességuier, L. (2018). Soil-related terroir factors: a review. *OENO One*, 52(2), 173-188.

Zyprian, E., Eibach, R., Trapp, O., Schwander, F. & Töpfer, R. (2018). Grapevine breeding under climate change: Applicability of a molecular marker linked to véraison. *Vitis*, 57, 119-123.

Original scientific paper

Variation of clusters and berry structural indicators of Cabernet sauvignon and Sauvignon blanc cv. (*Vitis vinifera* L.) under the influence of defoliation and harvest time

Nebojša Marković, Zoran Pržić

[1]Faculty of Agriculture University of Belgrade, Nemanjina 6, 11080 Belgrade, Serbia

Corresponding author: Zoran Pržić, zoranata4@yahoo.com

Abstract

Paper include two-year research in vineyard of King Peter I Karadjordjevic-Royal Winery at Oplenac-Topola municipality, on Cabernet sauvignon and Sauvignon blanc cv. Leaf removing was done at *veraison* and included control (no defoliation) and treatments with four and eight removed leaves. Harves was done it two terms, at full grape maturity and 15 days after. In paper it is presents values by defoliation treatments related to participation of berry skin, pulp and seeds in berry. Cabernet sauvignon had bigger percent of berry skin compared to Sauvignon blanc in both research years. Also, during the two research years, higher participation was recorded in a later harvest, while the lower value of this parameter was recorded in full maturity. With the largest percent of berry skin it is characterized treatment with four removed leaves (15.18%). Sauvignon blanc had less seeds participation in berry in all treatments. With the later harvest, pulp participation was less for both varieties.

Key words: structural indicators, defoliation, harvest time

Introduction

Cabernet sauvignon is widely spread and cultivated varieties. Due to its ecological adaptability today is present in 43 countries of the world, while Sauvignon blanc is growing in 31 countries. According to the percent and surfaces on which Cabernet sauvignon is cultivated in all world

occupies the first place, and Sauvignon blanc is on the fourth (Fregoni, 2010). Cabernet sauvignon originates from Bordeaux where it is distributed in valley of the Gironde river, Gravesac and the Medoc region, while Sauvignon blanc is primary white wine variety of Bordeaux and Loire valley (Walton, 2010).

The mechanical composition of cluster and berries (structural composition), represents ampelographic and technological characteristic of each variety. Structural indicators of clusters and berries represented through participation of individual elements such as participation of berry skin, pulp and seeds in berry and cluster, can significantly to affect variety technological characteristic or wine physical-chemical properties (Markovic et al., 2017). By defoliation and various harvesting terms can be change ratio: berry skin:pulp:seed, which affects concentration of anthocyanins and other flavonoid compounds essential for wine quality (Intrieri et al., 2008, Zivkovic et. al, 2016).

Žunić and Garic (2010) state that in Cabernet sauvignon cluster stem participates with 3-4.5%, berry skin with 8-11%, seeds with 2-4.5% and pulp with 75-80%. In Sauvignon blanc cluster stem participates with 3-4,5%, berry skin 9-14%, seeds 2,5-5,5% and pulp with 70-90%. Participation of berry skin, pulp and seeds in berry is in correlation with berry size (Matthews and Nuzzo, 2005). Berry growth increase the percentage of berry skin, pulp and seeds. The application of different ampelotechnical measures like leaf removing-defoliation, can change berry skin:pulp:seeds ratio. Optimal ripening time, i.e. the most favorable time for grapes harvesting and processing in wine often overlaps with the highest concentration of most phenolic compounds in berry. In this case it is phenolic maturity. From friut set, through veraison and finally to full grapes maturity, the drastic biochemical and physiological changes occur in berry itself, which can be demonstrated by different degrees of accumulation of certain phenolic compounds, especially flavonoids. Degree of synthesis and concentration of these compounds is in correlation with the participation of berry skin, pulp and seeds in the berry, which is changing depends on harvest time (Blesic, 2016).

In addition to harvesting time, mechanical composition of clusters and berries can also affected by defoliation. It is implemented with leaf removing from cluster zone. With defoliation to achieve positive effects it is necessary to pay attention to time and number of removed leaves. With removing of 15-25% leaves for 20-30 days before grape harvest, positive effects are very expresed and then the oldest leaves with reduced photosynthetic activity were removed, while the young leaves remain on the main and secundar shoots which are photosensitic most active (Nakalamić and Markovic, 2009; Keller, 2010).

Material and Methods

Research carried out in vineyard of King Peter I Karadjordjevic-Royal Winery at Oplenac-Topola municipality, on Cabernet sauvignon and Sauvignon blanc cv.

The vineyard planted with Sauvignon blanc (clone R 3) covers area of 3.7 ha and is located on the cadastral parcel KP 730/2 which belongs to Božurnja cadastral municipality. It is geographically positioned on GPS coordinates N 44°14'4 "and E 20°41'15". Vineyards baseof Oplenac hill with a slight inclination on east and southeast sides. Rows extend on east-west.Research on Cabernet sauvignon (clone ISV-FV 5) was carried out on cadastral parcel KP 629 of 0.55 ha belonging also to Božurnja cadastral municipality. Vineyard is geographically positioned on GPS coordinates N 44°14'35" and E 20°41'22".

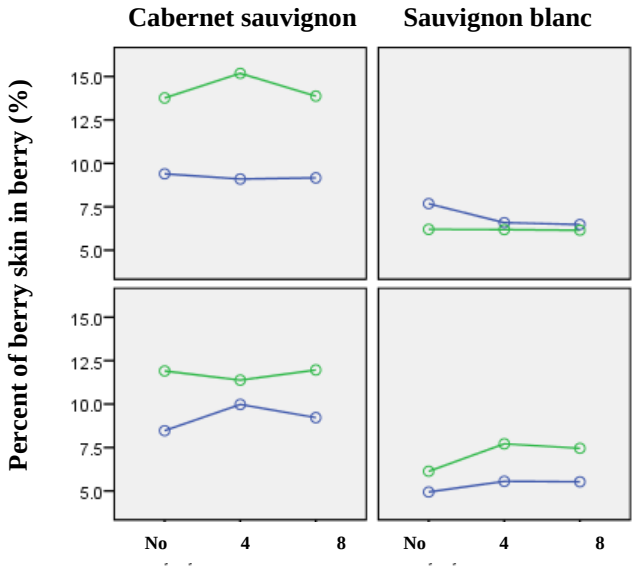
Both vineyards are characterized training system with height of 90 cm on which is Guyot pruning used. All experimental vines were uniformly pruned where was left spur with two buds and one arc with eight buds. Leaf removing was done at *veraison* and included control (no defoliation) and treatments with four and eight removed leaves. Harves was done it two terms, at full grape maturity and 15 days after. For a mechanical analysis, an average sample of ten clusters was harvested in two terms which was analyzed using by Prostoserdov method. The analysis was carried out at the laboratory of the Faculty of Agriculture, University of Belgrade, Department of Viticulture. The IBM SPSS Statistics 20 (statistical package for social sciences), Chicago, IL, USA, was used for data analysis. To investigate influence of factors (years, varieties, harvest times and defoliation treatments), a three-factor analysis of variance with fixed levels of factors was used for individual parameters. In the tests, a significance level of 0.05 was used.

Results and Discussion

Berry skin percent

Cabernet sauvignon recorded a bigger percent of berry skin douringh two study years compared to Sauvignon blanc. Also, in both years, biger participation was recorded at a later harvest, while a lower value of this parameter was recorded in full maturity (graph 1). In first year of study at late harvest, the largest berry skin percent was detected in treatment with four removed leaves (15.18%), while in other two treatments varied from 13.76-13.87%. In full maturity, slight variation was observed between treatments, with a slightly higher values in control (9.40%). Sauvignon blanc had a lower value in both harvesting terms. Control was

characterized with higher values of berry skin percent at both harvesting terms, with higher values in full maturity, and decreasing at later harvest. During the second year Cabernet sauvignon also had biger participation of berry skin at a later harvest, with less variation between treatments. In full maturity, was determined biger variation, with the largest berry skin percent was treatment with four removed leaves (9.98%), control (8.47%) and treatment with eight removed leaves (9.22%). Suvignon blanc in control at both harvest terms was with less participation of berry skin, values ranging from 4.94 to 6.13%. In treatment with four removed leaves, was recorded a slightly higher percent of berry skin and in treatment with eight removed leaves less.



**blue line-full maturity: green lime-late harvest; No-non defoliation; 4,8-removed leaves*

Graph 1. Percent of berry skin in Berry

Table 1. Trofactory ANOVA for Percent of berry skin in berry

Year	Sours of variation	Variance	F	p value
I	Variety	795,804	279,668	0,000
	Harvest term	137,175	48,207	0,000
	Treatment	1,548	0,544	0,582
	Variety *Harvest term	246,488	86,623	0,000
	Variety *Treatment	3,062	1,076	0,345
	Harvest term *Treatment	4,823	1,695	0,189
	Variety * Harvest term *Treatment	1,270	0,446	0,641
II	Variety	545,873	111,106	0,000
	Harvest term	137,758	28,039	0,000
	Treatment	7,373	1,501	0,228
	Variety *Harvest term	4,426	0,901	0,345
	Variety *Treatment	1,122	0,228	0,796
	Harvest term *Treatment	0,990	0,201	0,818
	Variety * Harvest term *Treatment	5,647	1,149	0,321

p = 0.05

The effect of the main effects: varieties, harvesting time and interactions of the variety*harvest time, was determined by ANOVA in the first year of reserach, while in the second it was determined as a statistically significant influence of the main effects of the variety and harvest time (table 1).

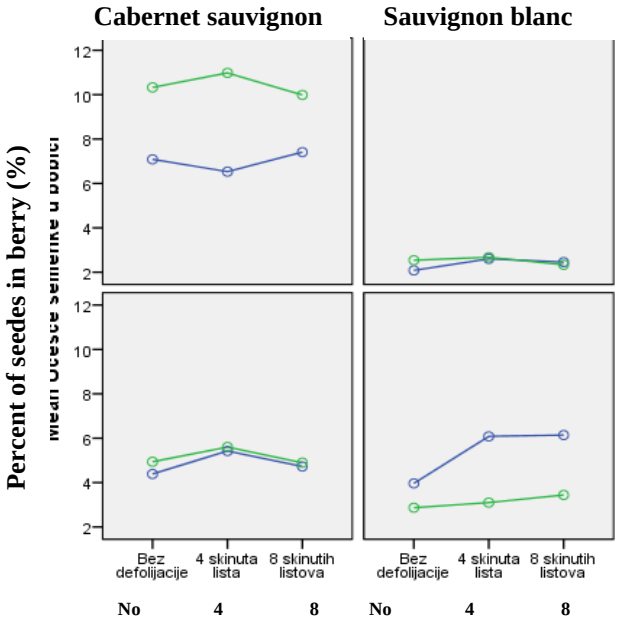
Percent of seedes in berry

With large participation seeds in berry in the first year of research were caracterized Cabernet Sauvignon in late harvest, while Sauvignon blanc were recorded less seeds in berry for all treatments. At Cabernet sauvignon large participation was recorded in treatment with four removed leaves (10.98%), while less participation was found in control (10.33%) and treatment with four removed leaves (9.99%). In full maturity, the highest percent was recorded in treatment with eight removed leaves (7.41%), while other two treatments recorded decreasing (7.09 and 6.53%).

Sauvignon blanc in the first year of study was characterized by a significantly lower percent of seeds in berry. A slight variation was recorded in control between two harvest terms, while values for the second treatment recorded a minimal variation (graph 2).

In the second year of study same variation trend was observed for Cabernet Sauvignon and Sauvignone blancin. Sauvignon blanc had large variation in percent of seed in berry. Higher values were recorded in full maturity for treatment with four and eight removed leaves (6.08 and 6.14%). In the period of later harvest percent of seeds in berry increase for all treatments.

Statistical analysis of data, using trophactorial ANOVA in the first year of study was determined influence of main factors: varieties and harvesting times. Also, there was influence of interaction variety*treatment. In the second year participation of seeds in berry was influenced by main factors: variety, harvesting time and treatment, and interaction of variety*harvest time (table 2).



**blue line-full maturity: green lime-late harvest; No-non defoliation; 4,8-removed leaves*

Graph 2. Percent of sedes in berry

Table 2. Trophactorial ANOVA for percent of seedes in berry

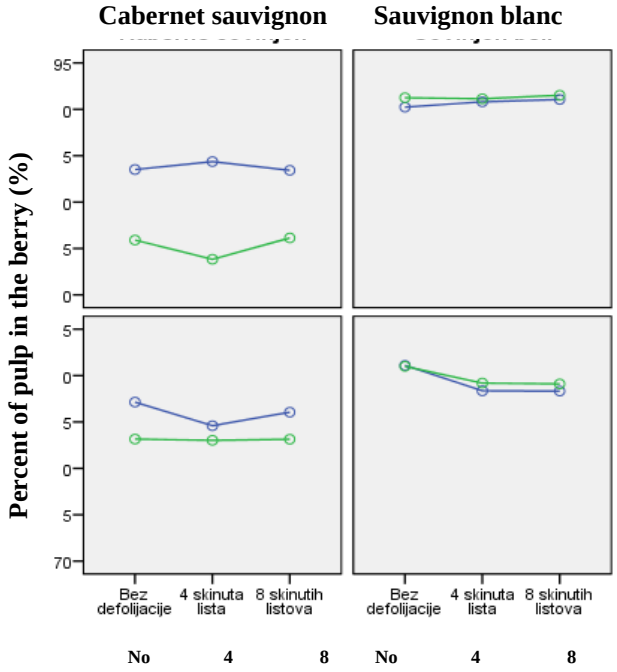
Year	Sours of variation	Variance	F	p value
I	Variety	1158,549	615,761	0,000
	Harvest term	93,264	49,569	0,000
	Treatment	0,392	0,209	0,812
	Variety *Harvest term	79,599	42,306	0,000
	Variety *Treatment	0,196	0,104	0,901
	Harvest term *Treatment	2,625	1,395	0,252
	Variety * Harvest term *Treatment	2,187	1,162	0,317
II	Variety	15,972	11,715	0,001
	Harvest term	28,444	21,156	0,000
	Treatment	11,133	8,166	0,000
	Variety *Harvest term	49,161	36,058	0,000
	Variety *Treatment	4,046	2,968	0,056
	Harvest term *Treatment	3,798	2,786	0,066
	Variety * Harvest term *Treatment	1,628	1,194	0307

p=0,05

Percent of pulp in berry

Cabernet Sauvignon had a large percent of pulp in berry in full maturity in both years of research, while percent of pulp in berry declined with late harvest. In the first year of full-maturity, treatment with four removed leaves showed a slight increase in percent of pulp in berry compared to other two treatments, while the same treatment in the later harvest showed a decrease in relation to the other two treatments. In the second year, higher values were recorded in control (87,14%) and treatment with eight removed leaves (86,05%), while in later harvest variation in treatment was minimal (graph 3). Sauvignon blanc in the first year of

research had an increase in percent of pulp in berry by treatments. Increasing was recorded from control to treatment with eight removed leaves. In the second year there was a decrease in percent of pulp in berry by all treatments. The decreasing was also recorded from control to treatment with eight removed leaves.



**blue line-full maturity: green lime-late harvest; No-non defoliation; 4,8-removed leaves*

Graph 3. Percent of pulp in Berry

Statistical analysis of data for the first year of study determined significant influence of variety, harvest time and interaction of the variety*harvest time. In the second year there was an influence of variety and interaction of variety*harvest time (table 3).

Table 3. Trophactorial ANOVA for percent of pulp in berry

Year	Sours of variation	Variance	F	p value
I	Variety	3874,908	559,880	0,000
	Harvest term	456,653	65,981	0,000
	Treatment	2,444	0,353	0,703
	Variety *Harvest term	606,240	87,595	0,000
	Variety *Treatment	1,736	0,251	0,779
	Harvest term *Treatment	9,963	1,440	0,242
	Variety * Harvest term *Treatment	6,304	0,911	0,405
II	Variety	748,526	79,369	0,000
	Harvest term	40,522	4,297	0,041
	Treatment	36,525	3,873	0,024
	Variety *Harvest term	83,072	8,808	0,004
	Variety *Treatment	7,922	0,840	0,435
	Harvest term *Treatment	6,993	0,742	0,479
	Variety * Harvest term *Treatment	1,616	0,171	0,843

p = 0.05

Application of different harvest terms and defoliation affects values of structural indicators of clusters and berries (Pržić, 2014). Defolation can makes structural changes of clusters and berries composition and changes in grape trunk microclimate wich results in a change in the distribution of light and temperature regime in cluster zone. Light effect is most often viewed through shading degree or illumination, which depends of defolation degree, i.e. percent of leaves removed from cluster zone (Jackson and Lombard, 1993).

Most of the flavonoid compounds react to these changes. Anthocyanins are synthesized in a higher percent, while flavonols respond positively to the change under ultraviolet light (Haselgrove et al., 2000; Spayd et al., 2002; Pereira et al., 2006). The anthocyanin concentration is closely linked to sugar accumulation. Shaded clusters contain less sugar but also less anthocyanins. Cloudy in longer time interval may also reduce anthocyanins accumulation. Only malvidin-3-glucoside can specifically be synthesized in the shade as it is not sensitive (Keller, 2010).

Conclusion

Based on research following conclusions can be made. Cabernet sauvignon had a large percent of berry skin in both years of study compared to Sauvignone blanc. In both years higher participation was recorded at later harvest, while the lower value of this parameter was recorded in full maturity. Increasing of berry skin participation was founded in treatment with four removed leaves. Increasing of participation of seeds in the berry for Cabernet sauvignon was founded in late harvest, while the Sauvignon blanc was detected for all treatments. Percent of pulp decreased with a later harvest. Sauvignon blanc had increasing from control to treatment with eight removed leaves. Bt statistical analysis of the was founded significant influence of variety, harvest time and treatment as well as interactions of variety*harvest time.

Acknowledgements

This study was realized as a part of the project "Studying climate change and its influence on the environment: impacts, adaptation and mitigation" (43007) financed by the Ministry of Education and Science of the Republic of Serbia within the framework of integrated and interdisciplinary research for the period 2011-2019.

References

Blesić, M. (2016). *Tehnologija vina*. Poljoprivredno-prehrambeni fakultet u Sarajevu. Sarajevo.

Fregoni, M. (2010). Le aree viticole storiche nel mondo: i loro vitigni, la loro protezione e la tipicita dei vini in esse ottenuti. *VIII International Terroir Congres*. Soave (VR), Italy, Proceeding vol 2. (5), 3-22.

Haselgrove, L., Botting, D., van Heeswijk, R., Hoj, P. B., Dry, P. R. & Ford, C. (2000). Canopy microclimate and berry composition: the effect of bunch exposure on the phenolic composition of *Vitis vinifera* L. cv. Shiraz grape berries. *Australian Journal of Grape and Wine Research*, 6:141-149.

Intrieri, C., Fiilippeti, I., Allegro, G., Centinari, M. & Poni, S. (2008). Early defoliation (hand vs mechanical) for improved crop control and grape composition in Sangiovese (*Vitis vinifera* L.). *Australian Journal of Grape and Wine research*. 14, 25-32.

Jackson, D. I. & Lombard, P. B. (1993). Environmental and management practices affecting grape composition and wine quality-A review. *American Journal of Enology and Viticulture*, 44, 409-430.

Keller, M. (2010). *The science of grapevines-anatomy and physiology*. Elsevier. London.

Marković, N., Pržić, Z., Rakonjac, V., Todić, S., Ranković-Vasić, Z., Matijašević, S. & Bešlić, Z. (2017). Ampelographic characterization of *Vitis* cv "Prokupac" clones by multivariate analysis. *Romanian Biotechnological Letters*, 22(5),12868-12875.

Matthews, M. A. & Nuzzo, V. (2005). Berry Size and Yield Paradigms on Grape and Wines Quality. *Acta Horticulturae*. No. 754, 423-436.

Nakalamić, A. & Marković, N. (2009). *Opšte vinogradarstvo*. Poljoprivredni fakultet, Zadužbina svetog manastira Hilandar. Beograd.

Pereira, G. E., Gaudillere, J. P., Pieri, P., Hilbert, G., Maucourt, M. & Deborde, C. (2006). Microclimate influence on mineral and metabolic profiles of grape berries. *Journal of agricultural and Food Chemistry*, 54, 6765-6775.

Spayd, S. E., Tarara, J. M., Mee, D. L. & Ferguson, J. C. (2002). Separation of sunlight and temperature effects on the composition of Vitis vinifera cv. Merlot berries. *American Journal of Enology and Viticulture*, 53, 171-182.

Pržić, Z. (2015). *Influence of partial defoliation on content of major aromatic and flavonoid complex compounds in grapes and wine.* Ph thesis, Faculty of agriculture University in Belgrade.

Walton, S. (2010). *The complete guide to wines and wine drinking. From Bordeaux to the Barossa Valley: an atlas of grapes, wines and producers and a master guide to buying, serving and enjoying wines of all types.* Hermes House an imprint of Anness Publishing.

Živković, J., Šavikin, K., Zdunić, G., Gođevac, D., Marković, N., Pržić, Z. & Menković, N. (2016). Influence of bunch morphology on quality of wines produced from clones of grape variety Prokupac. *J. Serb. Chem. Soc.* 81(8), 883–895.

Žunić, D. & Garić, M. (2010). *Posebno vinogradarstvo-ampelografija II*, Poljoprivredni fakultet Univerziteta u Prištini-Kosovskoj Mitrovici.

Original scientific paper

Potential winter buds fertility of the vine variety Rebo

Dushko Nedelkovski[1], Klime Beleski[1], Venelin Roytchev[2], Goran Milanov[1]

[1] *Institute of Agriculture- Skopje, R. N. Macedonia*

[2]*Agricultural University- Plovdiv, R. Bulgaria*

Corresponding author: Dushko Nedelkovski, duskosk8@yahoo.com

Abstract

The potential buds fertility along the fruit canes of the Rebo vine variety grown on Goblet and double Guyot were studied. It was established that in both pruning systems there were no dead primary buds in the winter buds, fruit buds with 3 inflorescences and inflorescences with length of more than 750 μm. The average value of the potential coefficients along the whole cane at the Goble pruning system is relatively lower 0.97% compared to double Guyot 1.12. If we want to obtain higher yield with Goble pruning system, a mixed pruning should be carried out, leaving canes or spurs. With the double Guyot yield will be obtained even from the spurs and the fruit canes should not be longer than 13 winter buds. In both variants, the yield will be mainly formed by green shoots with one inflorescence with the length of 350 μm to 550 μm and 550 μm to 750 μm.

Key words: variety Rebo, buds, indicators of potential fertility, double Guyot

Introduction

Studies of fruitfulness of buds in different varieties have always been a scientific interest because of the direct link between the number of set inflorescences in the bud and the obtained yields and quality of the grapes. Information on the potential productive capabilities of newly introduced or native varieties distributed on different areas is important for the vines so that the pruning system can be optimized for that individual variety. According to Брайков (1975, 1981) the pruning system on which the vine variety is grown significantly affects the

coefficient of potential fertility, the presence of more effective temperature sum, a good nutrient regime and favors the organogenesis of reproductive organs in the buds. There is a certain dependency between the formation of inflorescences in the winter buds and growth stages of the vine leading shoot (Божинова, 1973, 1975). There are a large number of scientific papers devoted to the formation and differentiation of inflorescences in the buds on the vine (Pratt 1971; Cirami, El-Zaftawi, 1973; Hegedus, 1972; Брайков, 1972; Бабриков, 1977; Брайков, Йорданов,1982; Йорданов, Брайков, 1986; Roychev, Braykov, 2001; Брайков, Ройчев, 2002; Брајков, Ројчев, 2003; Ројчев, Брајков, 2003; Неделковски, 2016; Неделковски и др., 2017; Nedelkovski et al., 2017; etc.). The purpose of this comparative study is to establish the parameters of the main indicators characterizing the potential fertility of buds (winter buds) at the wine variety Rebo grown on two pruning systems Goblet and double Guyot.

Materials and Methods

During the winter months in 2018 – 2019, 40 canes with a length of 11 buds (winter buds) were collected from vines grown on Goblet system and 15 winter buds from vines grown on double Guyo system. The investigated vines on both pruning systems were on the same age - 4 years. Samples of winter buds were taken through a knot and fixed in a water-spirit mixture - 70% ethyl alcohol, according to a method described by Брайков, (1972). Microscopic biometric observations of the anatomical structure of longitudinal slits from the winter buds with a stereoscopic MBC-2 binocular at an increase of 16x were made. The average values of the parameters of the potential fertility of buds were calculated: percentage of dead primary buds, potential coefficient of fertility (K) based on healthy buds and all winter buds, percentage of fruitless and fruitful buds, percentage of fruitful winter buds with 1, 2 and 3 inflorescences. According to the length of the inflorescences they were divided into four groups: first group - to 350 µm, second group - from 350 to 550 µm, third group 550 to 750 µm and fourth group - over 750 µm. Experimental vines were grown in northern part of the country near the town Kriva Palanka, with planting distances between the plants 3.2 x 1.2 m. During the study, no extreme changes in climatic factors have been observed that could influence the nature of the experimental work.

Results and Discussion

The main parameters of the potential fertility of buds at the variety Rebo grown on the pruning system Goblet indicate that there are no dead primary buds along the entire length of the shoot (Tab. 1). Potential coefficient of buds fertility (K) is mostly generalized and provides the most information about the biological production potential of each vine variety.

The values calculated on the basis of healthy and total number of buds are completely altered along the length of the fruitful shoot. The buds from the 3rd to 11th (node) were determined to have the highest values for the indicators that are extremely important for the preliminary individual vine load. That means that during the pruning, depending on the use of the grapes, we can be left spurs with 4 to 7 winter buds and fruitful canes with 11 winter buds. Their average values are 1.00 (3rd, 7th, 11th bud); 1.05 (4th-6th-8th-10th bud) to 1.10 (5th-9th bud). The average value of the potential coefficients for bud fertility for the whole shoot is 0.97%, which means that this variety in this particular growing area and agrotechnical conditions the pruning system, shows good potential fertility. To obtain higher yields, a mixed pruning system should be performed by leaving fruit shoots or spurs. The average percentage of fruitful primary buds is high - 84.39%, the values for this indicator are increasing from 50.00% to 70.00% in 1st to 2nd bud to 90.00% in sector 4th - 9th bud of the fruit cane. Morphogenesis analysis shows that predominate fruit buds with 1 inflorescence an average of 86.17%, followed by those with 2 inflorescences - 13.83%, and winter buds with 3 inflorescences are missing. The percentage of buds with one inflorescence decreases from the base of the cane: the 1st bud - 100.0% to 5th bud - 77.78%, in the middle sector the values increase from 6th to the 8th bud from 83.33 % to 88.89%, decreased in the 9th bud - 77.78% and increased to the top of the fruit cane to 87.50% in the 11th bud.

The realization of potential bud fertility in actual bud fertility depends strongly on the degree of inflorescences differentiation in the winter buds. With relatively higher average percentages are winter buds with size of inflorescence form 350 µm to 550 µm - 53.83% (second group) and 550 µm to 750 µm - 46.17% (third group). The group of inflorescences with the largest share in the yield formation at this variety is the one with inflorescences size from 350 µm to 550 µm (first group), with lowest values in the cane sector from 9th (27,27%) to 10th (35,86%) bud, and highest values at the base of fruit cane in the sector from the 1st to 3rd bud - 80,00% - 70, 00%. The third group of inflorescences can be relied for obtaining bigger grape clusters if the pruning system is designed to leave fruit canes up to 11 buds long. The smallest

inflorescences up to 350 μm and poorly differentiated inflorescences, as well as the largest and best differentiated inflorescences with a length of over 750 μm are missing. According to the parameters of the main indicators of the potential buds fertility of the grape variety Rebo, grown on the pruning system double Guyot, no primary buds are lost in the winter buds during the vegetation period, which is extremely favorable for the formation of grape yield (Table 2). This means that both potential coefficients based on healthy and all buds, will have the same values along the entire length of the fruit cane. Their average value is comparatively higher than the one grown on Goblet system - 1,17. The potential fertility of the first few buds in the sector from 1st to 3rd bud is 1,20, then the coefficient increases in the 4th bud to 1,30 and 1,40 in the 5th bud, and in the 6th bud again decreases to 1,20. From this sector to the end of the fruit cane the coefficients decrease with a certain deviation in the 9th bud - 1.20 and reach 1.00 in the 11th bud. The summarized data for potential fertility of the buds for these experimental conditions show that the vines from the variety Rebo grown on double Guyo system, the yield can also be obtained from the spurs, and the fruit canes should not be longer than 11 winter buds. The percentage of fruit primary buds is very high, almost at the entire length of the cane and varies slightly from the 1st to the 11th bud from 90.00% to 100.00%. The % of infertile buds in this cultivated on Guyot is 6.36%, twice as low as those of the previous one (Goblet system) - 15.61%. They are mainly located at the base and at the end of the fruit cane.

In most of the fruit buds one inflorescence is set - an average of 74.94%, followed by those with two inflorescences - 15.96%. From the 1st to the 5^{th} bud, the buds with 1 inflorescence are from 66.67% to 60.00%, and then their amount increases from 74.44% in the 6th bud to 88.89% in the 11th bud. Winter buds with three inflorescences were not observed in any of the samples. These data show that the yield of this variety will mainly be formed by shoots with one inflorescence. Buds with two inflorescences are relatively more in the sector form 1st to 3rd bud (33,33%) and 4th (36,67%) - 5th bud (40,00%).

Table 1. Basic parameters of potential buds fertility at the variety Rebo grown on Goblet pruning system

Parameters	Buds along the length of the fruitful cane											Average
	1	2	3	4	5	6	7	8	9	10	11	
1. Dead primary buds, %	-	-	-	-	-	-	-	-	-	-	-	-
2. K based on healthy buds	0,5	0,75	1	1,05	1,1	1,05	1	1,05	1,1	1,05	1	0,97
3. K based on all buds	0,5	0,75	1	1,05	1,1	1,05	1	1,05	1,1	1,05	1	0,97
4. Fruitless primary buds, %	50	30	10	10	10	10	10	10	10	10,6	11,1	15,61
5. Fruitful primary buds, %	50	70	90	90	90	90	90	90	90	89,4	88,9	84,39
6. Fruitful buds with:												
1 inflorescence, %	100	94,4	88,9	83,3	77,8	83,3	88,9	83,3	77,8	82,6	87,5	86,17
2 inflorescences, %	-	5,56	11,1	16,7	22,2	16,7	11,1	16,7	22,2	17,4	12,5	13,83
3 inflorescences, %	-	-	-	-	-	-	-	-	-	-	-	-
7. inflorescences with length (%):												
to 350 μm	-	-	-	-	-	-	-	-	-	-	-	-
from 350 – 550 μm	80	75	70	57,7	45,5	52,7	60	43,6	27,3	35,9	44,4	53,83
from 550 – 750 μm	20	25	30	42,3	54,6	47,3	40	56,4	72,7	64,1	55,6	46,17
above 750 μm	-	-	-	-	-	-	-	-	-	-	-	-

K – coefficient of the potential bud fertility

Table 2. Basic parameters of potential buds fertility at the variety Rebo grown on double Guyot pruning system

Parameters	Buds along the length of the fruitful cane											Average
	1	2	3	4	5	6	7	8	9	10	11	
1. Dead primary buds, %	-	-	-	-	-	-	-	-	-	-	-	-
2. K based on healthy buds	1,2	1,2	1,2	1,3	1,4	1,2	1	1,1	1,2	1,1	1,00	1,17
3. K based on all buds	1,2	1,2	1,2	1,3	1,4	1,2	1	1,1	1,2	1,1	1,00	1,17
4. Fruitless primary buds, %	10	10	10	5	-	5	10	5	-	5	10	6,36
5. Fruitful primary buds, %	90	90	90	95	100	95	90	95	100	95	90	93,64
6. Fruitful buds with:												
1 inflorescence, %	66,67	66,67	66,67	63,33	60	74,44	88,89	84,44	80	84,44	88,89	74,94
2 inflorescences,%	33,33	33,33	33,33	36,67	40	25,56	11,11	15,56	20	15,56	11,11	15,96
3 inflorescences,%	-	-	-	-	-	-	-	-	-	-	-	-
7. inflorescences with length (%):												
to 350 µm	-	4,17	8,33	4,17	-	-	-	-	-	5	10	3,78
from 350 – 550 µm	83,33	75	66,67	65,48	64,29	67,14	70	55,83	41,67	40,83	40	60,93
from 550 – 750 µm	16,67	20,83	25	30,35	35,71	32,86	30	44,17	58,33	54,17	50	36,19
above 750 µm	-	-	-	-	-	-	-	-	-	-	-	-

K – coefficient of the potential bud fertility

By cultivating Rebo on double Guyot pruning system the grape yield will be determined by inflorescences with size from 350 µm to 550 µm - 60.93% (second group) and 550 µm to 750 µm - 36.19% (third group). Inflorescences from group I were also noted, with length of up to 350 µm, an average of 3.78%. They are observed in the sector from 2nd to 5th bud and the 10th and 11th bud and should not be relied on their significant increase in yield. There are no inflorescences with sizes above 750 µm, which is most likely a varietal characteristic.

Along the fruit cane inflorescences of the second group are mostly present in the sector from 1st to 7th bud from 64.29% (5th bud) to 83.33% (1st bud). In the rest of the cane, the percentages of the inflorescences of the same group decreased to 40.00% in the 11th bud. The change in the amount of inflorescences of the group III along the length of the fruit cane is in the reverse order.

Conclusion

The coefficients of potential fertility of the buds along the fruit cane of the grape variety Rebo grown on the pruning system Goblet have highest values in the sector from the 3rd to the 11th bud. According to this, during the pruning, depending on the use of the grapes, spurs with 4-7 winter buds and fruit canes with 11 winter buds can be left. The average percentage of fruitful primary buds is high - 84.39%, fruit buds with 1 inflorescence predominate with an average of 86.17%. The average percentages of winter buds with inflorescences with sizes from 350 µm to 550 µm, are relatively high, 53.83% and from 550 µm to 750 µm - 46.17%.

When this variety is cultivated on double Guyot pruning system the potential fertility of the buds is significantly greater at the base of the cane and in the sector from 1st to 3rd bud the coefficient of potential bud fertility is 1,20, then the coefficient increases in the 4th bud to 1,30 and 1,40 in 5th bud, and in the 6th bud decrease to 1,20. From this sector to the end of the fruit cane the coefficients decrease with a certain deviation in the 9th bud - 1.20 and reach 1.00 in the 11th bud. The percentage of fruitful primary buds is very high very high almost the entire length of the canes from 95.00% to 100.00%. Only one inflorescence is set in most of the fruit buds an average of 79.35%. The inflorescences with dimensions from 350 µm to 550 µm - 51.35% and from 550 µm to 750 µm - 36.19% dominate.

From the investigation in both pruning systems dead primary buds in the winter buds, fruit buds with 3 inflorescences and inflorescences with a length of more than 750 µm were not found. The average value of the potential coefficients for the whole cane for the pruning system

Goblet is relatively smaller 0.97 of the same coefficient for the pruning system double Guyot - 1.17. When the variety is grown on the first system to obtain a higher yield, a mixed pruning system should be carried out, leaving fruit spurs or small canes, and when it's grown on the second system the yield will be obtained from the spurs and canes with length no longer then 11 winter buds. In both variants the yield will be formed mainly by the shoots with one inflorescence with a length of 350 µm to 550 µm and 550 µm to 750 µm.

References

Бабриков, Д. (1977). *Биологични основи на резитбата и прогнозирането на добивите при десертните сортове лози*. Дисертация, 482 с.

Божинова, И. (1973). *Наследяване на основните стопански ценни признаци на десертното грозде в хибридното потомство и проучване на лозовите сортове, свързани с ранозрелостта*. Дисертация. Пловдив, 281 с.

Божинова, И. (1975). Изучаване морфофизиологията на лозата II. Морфогенезис на зимните очи по дължината на основния летораст. *Градинарска и лозарска наука*, 8, 110-118.

Брайков, Д. (1975). Влияние на температурните условия върху продължителността на етапите на органогегенезиса при лозата. *Градинарска и лозарска наука*, год. XII, 2, София, 108-114.

Брайков, Д. (1972). *Органогенеза при лозата в зависимост от биологията на сорта и някои екологични условия*. Дисертация, 274 с., Пловдив.

Брайков, Д. (1981). *Биолого-екологични проучвания върху някои вегетативни и репродуктивни процеси при лозата*. Дисертация, Пловдив, 346 с.

Брайков, Д. & Йорданов, С. (1982). Влияние на натоварването с очи върху родовитостта на сорта Мавруд. *Лозарство и винарств*о, 2, 19-22.

Брайков, Д. & Ройчев, В. (2002). Потенциални агробиологични показатели, влияещи върху фармирането на добива при десертните лозови сортове Супер ран Болгар, Брестовица и Болгар. *Лозарство и винарство*, 6, 15-20.

Брајков, Д. & Ројчев, В. (2003). *Потенцијалните можности за принос на сортите винова лоза Каберне Совиньон и Алиготе*. Зборник на научни трудови. I Балкански и III Македонски симпозиум по лозарство и винарство, 131-137. Скопје, 26-28 ноември 2003.

Йорданов, С. & Брайков, Д. (1986). Реализация на потенциалната родовитост на сорта Мавруд в зависимост от натоварването. Висш селскостопански институт - Пловдив, *Научни трудове*, т. XXXI, кн. 2, Лозарство, 11-20.

Неделковски, Д. (2016). Влияние на някои летни резитбени операции върху потенциалната родовитост на пъпките при лозовия сорт Вранец. *Лозарство и винарство*, 3, 8-16.

Неделковски, Д., Ройчев, В., Иванов, А. & Белески, К. (2017). Влияние на надморската височина и някои летни резитби върху параметрите на потенциалната родовитост на зимните очи при лозовия сорт Вранец. Journal of Mountain Agriculture on the Balkans, 2017, 20 (3), 139-152. Research Institute of Mountain Stockbreeding and Agriculture, Troyan.

Рojчев, В. & Брајков, Д. (2003). *Испитуванье на важни параметри кои ја определуваат потенцијалната родност на некои десертни сорти винова лоза.* Зборник на научни трудови. I Балкански и III Македонски симпозиум по лозарство и винарство, 138-143, Скопје, 26-28 ноември 2003.

Cirami, R. & El-Zaftawi, B. (1973). Fruitfulness and cane pruning of Zante Curant. Austrol. J. *Exp. Agr. and Amim. Husb*., N 62.

Hegedus, A. (1972). A szolorugyek termekenyseget befolyasoloteny ezok. *Szolo-es gyumolistermesztes*, 7.

Nedelkovski, D., Roychev, V., Beleski, K. & Mokreva, T. (2017). The Effects of the Summer Pruning Operations on the Winter Buds Productivity of cv. Vranec (*Vitis vinifera* L.). *Agro-knowledge Journal*, vol. 18, no. 3, 155-166.

Pratt C. (1971). Reproductive anatomy in cultivated grapes. *Am. J. Enol. Vitic*., 22, 92-109.

Roychev, V. & Braykov, D. (2001). Identification of Potential Bud Fertility Parameters of Grapevine Cultivars Bolgar and Mavrud in the Autumn - Winter Period. *Bulgarian Journal of Agricultural Science*, 7, 381-392. National Centre for Agrarian Sciences.

Original scientific paper

The quality of grape and wine of Merlot and Blatina varieties in the agroecological conditions of the Trebinje vineyard

Tijana Banjanin[1], Nikolina Lisov[2], Aleksandar Petrović[2], Zorica Ranković-Vasić[2], Milenko Blesić[3]

[1] University of East Sarajevo, Faculty of Agriculture, Republic of Srpska, B&H

[2] University of Belgrade, Faculty of Agriculture, Belgrade, Serbia

[3] University of Sarajevo, Faculty of Agricultural and Food Sciences, Sarajevo, B&H

Corresponding author: Tijana Banjanin, tijanapekic@hotmail.com

Abstract

The aim of this paper is to present the quality of grape and wine of Merlot and Blatina varieties in the agro ecological conditions of the Trebinje vineyard, during the vintages of 2016 and 2017. The vineyards were established in 2004 (Merlot) and in 2013 (Blatina), at an altitude of 269 m, with the planting distance of 2.8 x 1 m for Blatina and 2.8 x 0.9 m for Merlot. The Merlot and Blatina grape varieties were grafted on *Berlandieri* × *Riparia* Kober 5BB rootstock. The research included analysis of the sugar, total acid content and pH as parameters of grape quality. The following parameters of wine quality were analyzed: alcohol content, total acid, total ash, content of extract and total phenols. The quality of the grapes, grown in the conditions of Trebinje vineyard is suitable to produce quality red wines.

Key words: sugar content, alcohol content, total acid, ash and phenols.

Introduction

The biological characteristics of the variety together with the ecological characteristics of the region and the applied agro-technical measures are the most important factors for successful viticultural production, Sivčev et al. (2012). Considering the ecological conditions, almost every country has its own autochthonous grapevine varieties formed over a long time. In

Herzegovina there is large number of grape varieties, out of which some are native (Žilavaka, Blatina, Trnjak, Bena etc.), while a certain number of varieties was introduced (Banjanin et al., 2018).

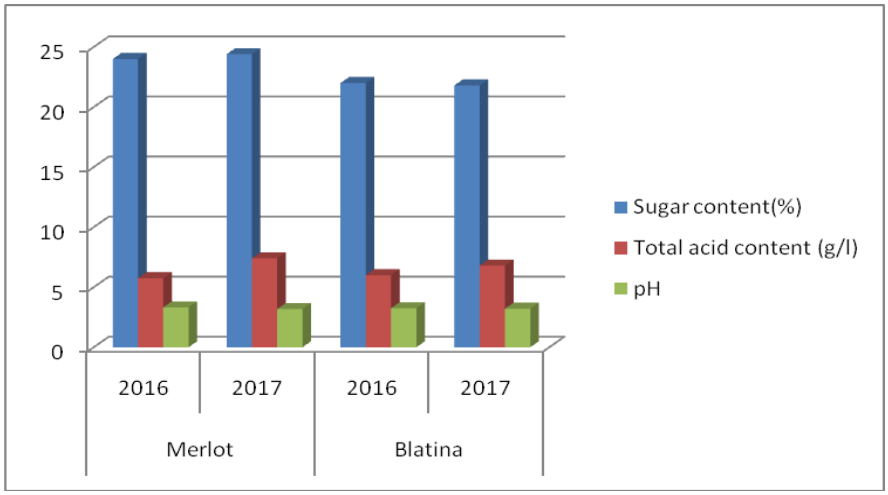
Blatina is used to produce red wines but as it has functional female flowers, its cultivation is limited by the need for a pollinator. Therefore, Blatina is increasingly being replaced by the Montenegrin cultivar Vranac. Merlot was introduced from France to the territory of Herzegovina in the 19th century and today is one of the most widespread grape varieties in that area. The main purpose of this research is to present the quality of grape and wine of Merlot and Blatina varieties in the agro ecological conditions of the Trebinje vineyard. Wine quality is the result of a lot of interactions, which include geological and soil conditions, climate and the applied wine technology. That lead to producing wine with certain quality parameters. According to Ribereau-Gayon et al. (2006), content of alcohol is important wine quality parameter but not only and the most essential as many consumers think. Content of alcohol and acidity make it possible to avoid any noticeable spoilage for a long time. Also, an increase of alcohol content lead to increase of total anthocyanins and total phenolic compounds because of its useful solvent properties dissolving phenols from pomace during fermentation and solubilizing certain odoriferous molecules and certainly contributes to the expression of aromas in wine. In addition to influencing the sensory properties of wines, content of alcohol and total acid content have a great impact to their stability and quality maturation and aging. Red wines are stable at lower acidity because of the presence of phenolic compounds which enhance acidity and help to maintain stability throughout aging (Ribereau-Gayon et al., 2006). The quality of red wines depends to great extent on their phenolic composition, the most important components which determine the color, mouthfeel, astringency and bitterness of the wine (Ivanova-Petropulos et al., 2016). Ash content is an obligatory analysis for certified wines to be placed on the market place. Determination of the ash is important to the enologist for a variety of reasons: legal, health, taste and regional definition (Košmerl and Bavčar, 2003). Also, very important quality factor is total extract. Wines with low contents of the extract are non-harmonious and empty, while wines with too much extract are heavy and dense. Preferred fullness and harmony are the characteristics of wines with good extract content. The quantities of the extract in wines depend on the cultivar of the vine, the way and the conditions of its cultivation, the degree of maturity of the grapes and the applied wine technology (Ribereau-Gayon et al., 2006).

Material and Methods

In this research as a material were used Merlot and Blatina grape varieties. The study of the quality of grape and wine of the grapevine varieties is done during the vintages of 2016 and 2017. The experiment was set up at the location of Petrovo and Popovo polje, Trebinje. The vineyards were established in 2004 (Merlot) and in 2013 (Blatina), at an altitude of 269 m, with the planting distance of 2.8 x 1 m for Blatina and 2.8 x 0.9 m for Merlot. During the research year in experimental vineyards, basic measures of pruning were applied, as well as protection from the most important causes of diseases and pests. The research included analysis of the sugar, total acid content and pH as parameters of grape quality. The following parameters of wine quality which were analyzed: alcohol content, total acid, total ash, content of extract and total phenols. Grape processing was done within the microvinfication process. 10 kg of grapes was processed and for alcoholic fermentation was used yeast Lalemand, Uvaferm at a concentration of 40 g/hl. Fermenters during fermentation kept in a constant temperature chamber of 25°C. The wines are not clear or filtered. Chemical analysis of wine was done after 12 months and included one wine per variety for both examined years. Analyzes of must and wine was done by Daničić (1988) methods including method of neutralization for total acid content and ebullioscopy method for alcohol content. Total phenolic content of the wine samples was estimated by the Folin-Ciocalteu (FC) method using gallic acid as a standard (Tanner and Brunner, 1979). The results were expressed in mg/l of gallic acid equivalents (mg GAE^{-1}).

Results and Discussion

The chemical composition of the must is very complex. It varies widely, depending on the variety, ecological conditions, applied agro-technology, degree of maturity of grapes, health status, etc. (Vujović, 2009). In most cases the content of the sugar in the must in the grapes of *Vitis vinifera L.* varied between 16-25%. The values of chemical composition of the must of the tested varieties are presented in Graph. 1.



Graph 1. The quality parameter of grape

The Merlot variety has higher sugar content in both years of observation (Graph.1). The sugar content in grape must was 24.0% (2016) and 24.4% (2017) for Merlot and 22.0% (2016) and 21.8% (2017) for Blatina variety, our results is in accordance with Blesić et al. (2013) and Cvetković et al. (2010).

The highest total acid content in grape juice occurs before the appearance of the verasion phase, while it gradually decreases during ripening, which depends on the variety and ecological conditions of growth (Jeromel et al., 2007). The quantity of acidic grape varieties varies in very wide limits, from 3 to 12 g/l, most often 5-8 g/l, which depends on the variety, ecological conditions, degree of maturity of grapes, etc. (Nikolić, 2012). The results of our studies (Graph. 1) showed that the total acid content in grape juice was 6.0 g/l for Blatina (2016) and 5.75 g/l for Merlot (2016). For Blatina variety total acid content was 6.8 g/l (2017) and 7.4 g/l (2017) for Merlot variety. Our results are in accordance with results of Vukosavljević et al. (2011) and Rotim et al. (2017).

The value of the pH of must and wine generally ranges between 2.7 and 3.9 (Katalinić et al., 2010). The pH value in Merlot must was 3.18 (2017) and 3.32 (2016), and in Blatina must pH was 3.25 (2016) and 3.21 (2017). The pH value of the research varieties is slightly lower than the results stated by Pajović et al. (2009) for Podgorica vineyards while is in accordance with the values stated by the same authors for the Skoplje wine growing region.

The results of our studies of the chemical composition of the wine are given in the Table 1. The alcohol content in Blatina wine ranged from 12.8 %v/v (2016) to 12.7 %v/v (2017), average 12.75 %v/v and in Merlot wine from 13.65 %v/v (2016) to 14.2 %v/v (2017), average 13.92 %v/v. Total acid content in the years of research were 4.91 g/l for the Blatina and 4.64 g/l for

the Merlot variety. In both research years, Merlo had a higher content of the total extract than the Blatina variety.

Table 1. The quality parameter of wine

Variety	Merlot			Blatina		
Year	2016	2017	Average	2016	2017	Average
Alcohol content (%)	13.65	14.20	13.92	12.80	12.70	12.75
Total acid (g/l)	4.56	4.72	4.64	4.58	5.23	4.91
Total ash	2.40	1.92	2.16	2.81	2.30	2.55
Total phenols (g/l)	1.25	1.16	1.21	1.87	1.91	1.89
Content of extract (g/l)	26.8	27.5	27.15	25.5	26.1	25.8

Higher content of total phenols and ashes in both research years has Blatina variety (Tab. 1). An increase of alcohol content lead to increase of total anthocyanins and total phenolic compounds (Sacchi et al., 2005). The extraction of phenolic compounds increases progressively with the length of maceration and alcoholic fermentation. In addition to alcohol content, some other factors such as temperature and maceration time increase content of mineral compounds, which are responsible for higher total ash content of wine samples (Damijanic et al., 2012; Petrovic et al., 2018; Lisov et al., 2018).

Conclusion

On the base of the results obtained the following can be concluded:

Grape quality parameters (sugar content, total acid content and pH) of both varieties indicate high quality when growing on the area of Trebinje vineyards.

The quality of the wine of the tested varieties was at the level of high quality and quality varieties.

From the point of the quality of grapes and wines, Merlot and Blatina varieties, exhibited all the positive features and are therefore recommended for further expansion in Trebinje vineyards area.

References

Banjanin, T**.,** Ranković-Vasić, Z. & Matijašević, S. (2018). Technological Characteristics of the Vranac and Cabernet Sauvignon Grapevine Varieties in the Conditions of the Trebinje Vineyards. *Agro-knowledge Journal*, 19(3)*, 167-175.

Blesić, M., Mijatović, D., Radić, G. & Blesić, S. (2013). *Praktično vinogradarstvo i vinarstvo.* Fojnica doo-Sarajevo.

Cvetković, D., Stanković, S., Vitošević & I. & Čurović, V. (2000). *The yield and quality of grapes and wines of the Merlot variety in the conditions of the Vinaracki vineyard*. Zbornik naučnih radova Instituta PKB Agroekonomik, 6(1), 307-310.

Damijanić, K., Staver, M., Kovačević Ganić, K., Bubola, M. & Palman, I. (2012). Effects of Maceration Duration on the Phenolic Composition and Antioxidant Capacity of 'Teran' (*Vitis vinifera* L.) Wine. *Agriculturae Conspectus Scientifi cus.* 77, 2.

Daničić, M. (1988). *Praktikum iz tehnologije vina.* Poljoprivredni fakultet Zemun, 46-200.

Ivanova-Petropulos, V., Durakova, S., Ricci, A., Parpinello, G.P. & Versari, A. (2016). Extraction and evaluation of natural occurring bioactive compounds and change in antioxidant activity during red winemaking. *Journal of Food Science and Technology*, 53(6), 2634-2643. DOI 10.1007/s13197-016-2235-7.

Jeromel, A., Herjavec, S., Kozina, B., Maslov, L. & Bašić, M. (2007). Composition of organic acids in grapes, must and wine clones of Chardonnay. *Poljoprivreda*, 13(2), 35-40.

Katalinić, V., Generalić, I. & Skroza, D. (2010). *Prerada grožđa*. Sveučilište u Splitu, Hemijsko-tehnološki fakultet. Split.

Košmerl, T. & Bavčar, D. (2003). Determination of ash content in Slovenian wines by empirical equations. *Zb. Bioteh. Fak. Univ. Ljubl.*, 81(2), 325–334.

Lisov, N., Čakar, U., Petrović, A., Madzgalj, V. & Gojković-Bukarica, Lj. (2018). *Extraction kinetics of some phenolic compounds during vinification of grape variety Cabernet Sauvignon and its antioxidant properties*. 6th Workshop Specific methods for safety and quality, September 27th, 2018, Vinca Institute of Nuclear Sciences, Belgrade, Serbia, 21-24.

Nikolić, D. (2012). *Oplemenjivanje vinove loze*. Monografija. Fleš – Zemun. Beograd.

Pajović, R., Popović, T., Boskov, K. & Beleski, K. (2009). Economic and technological characteristics of the grapes of the Vranac variety and introduced varieties of Cabernet Sauvignon and Merlot in the conditions of Podgorica's vineyard (Montenegro) and the Skolje Vineyard (Macedonia). *Agroknowledge*, 10(1), 89-96.

Petrović, A., Lisov, N., Madzgalj, V., Čakar, U., Despotović, S. & Gojković-Bukarica, Lj. (2018). *Extraction kinetic of resveratrol and total phenolic compounds during vinification of grape varieties Merlot and Smederevka*. 9th Central European Congress on Food (CEFood), 24-26 May 2018, Sibiu, Romania, 72.

Ribereau-Gayon, P., Glories, Y., Maujean, A. & Dubourdieu, D. (2006). *Handbook of Enology*, Volume 2. The Chemistry of Wine Stabilization and Treatments (2nd ed.). Chichester: John Wiley & Sons, Ltd.

Rotim, N., Gašpar, M. & Perić, I. (2017). Wine cultivars of grape vine in Herzegovina. *Glasnik Zaštite Bilja*, 40(5), 78-85.

Sacchi, K.L., Bisson, L.F. & Adams, D.O. (2005). A Review of the Effect of Winemaking Techniques on Phenolic Extraction in Red Wines. *Am. J. Enol. Vitic.* 56, 3.

Sivčev, B., Ranković-Vasić, Z., Nikolić, D., Ivanišević, D., Radojević, I., Atanacković, Z. & Korać, N. (2012). *Clonal research of black wine grape cultivars in different Serbian localities*. 47th Croatian and 7th International Symposium on Agriculture, 778-782.

Tanner, H., & Brunner, H.R. (1979). *Gentranke-Analytik.* Verlag Heller Chemie und Verwaltunsgesellschaft mbH, Germany.

Vujović, M. (2009). *Vinogradarstvo, grožđe okupano suncem.* Riznica. Beograd.

Vukosavljević, V., Boškov, K., Pajović, R., Stojanov, M., Đurić, M., Murtić, S. & Kojović, R. (2011). *Rodni potencijal i kvalitet sorte merlo u trsteničkom vinogorju. XVI Savjetovanje o biotehnologij.*, Čačak, Book of papers, 16(18), 385-389.

Квалитет грожђа и вина сорти Мерло и Блатина гајених у агроеколошким условима Требиња

Тијана Бањанин[1], Николина Лисов[2], Александар Петровић[2], Зорица Ранковић-Васић[2], Миленко Блесић[3]

[1] Универзитет у Источном Сарајеву, Пољопривредни факултет, Источно Сарајево, БиХ

[2] Универзитет у Београду, Пољопривредни факултет, Београд, Србија

[3] Универзитет у Сарајеву, Пољопривредно-прехрамбени факултет, Сарајево, БиХ

Аутор за кореспонденцију:Тијана Бањанин, tijanapekic@hotmail.com

Сажетак

Циљ овог рада је да представи квалитет грожђа и вина сорти Мерло и Блатина у агроеколошким условима Требиња, током вегетације 2016. и 2017. године. Виногради су подигнути 2004. године (Мерло) и 2013. године (Блатина), на надморској висини од 269 m, са растојањем од 2,8 x 1 m за Блатину и 2,8 x 0,9 m за Мерло. Сорте грожђа Мерло и Блатина су калемљене на лозну подлогу Berlandieri x Riparia Kober 5BB. Истраживање је обухватило анализу шећера, укупних киселина и pH као параметара квалитета грожђа. Анализирани су и сљедећи параметри квалитета вина: садржај алкохола, укупних киселина, укупни пепео, укупни екстракт и укупни феноли. Квалитет грожђа које се узгаја у условима Требињског виногорја погодан је за производњу квалитетних црних вина.

Кључне ријечи: садржај шећера, садржај алкохола, укупне киселине, укупни пепео и феноли

Original scientific paper

Germination of floral species depending on the applied biostimulant

Svjetlana Zeljković[1], Jelena Davidović Gidas[1], Vida Todorović[1], Milica Pašalić[1]

[1] *University of Banja Luka, Faculty of Agriculture, Repablic of Srpska, BiH*

Corresponding author: Svjetlana Zeljković, svjetlana.zeljkovic@agro.unibl.org

Abstract

The aim of this study was to examine the impact of biostimulant Radifarm® on the seed germination and germination energy of the two floral species. As a material the *Bellis perennis* L. and *Viola* x *wittrocikana* Gams. seeds were used. By applying biostimulant in the germination phase, it is possible to create better conditions for the growth and development of the germ and germination. The experiment was conducted in laboratory condition and consisted of control (K) and treatment with biostimulant Radifarm® (T1 0.25% and T2 0.5%). After 7 days germination energy and after 14 days germination of the seeds were tested. The highest average values of the germination energy of the *Bellis* were recorded in the treatment plants (89.5% T2, 89% T1), while the lowest values were recorded in control plants (85%). The highest average germination values were also recorded in treatment (93.5% T2, 92% T1), and the lowest in the control group (88.5%). The best germination energy of *Viola* seeds were in treatment group (T2 87.5%, T1 83%), while control group had the lowest germination energy of 74%. The highest average germination values of *Viola* seeds were recorded in T2 91%, while in T1 germination was 89%. The lowest average germination value was 81% in the control group. It can be concluded that biostimulant treatment is recommended in the seed germination phase, but in order to achieve the effects it would be even more necessary to prevent the seeds by some of the fungicides.

Key words: Biostimulant, Germination, Germination energy, Floral species

Introduction

The demands and needs for the production of floral species are increasing because throughout various activities the focus is placed on the arrangement of parks and public areas. That is why the main task of each producer of planting material should be the production of high quality seedlings. For decoration of public areas and home gardens numerous annual and biannual flower species are used, among which one of the most commonly used are *Bellis perennis* L. and *Viola* x *wittrocikana* Gams.

They are characteristic for early spring bloom period, low temperature tolerance, easy propagation and minimal labor requirements. They are fast growing and suitable for gardens and flowerbeds. For the propagation of annual flower seedling or for direct sowing, seed quality is essential. Poor and ununiformed germination is an undesirable seed property. Fast and homogenous germination provide both economic and environmental benefits in agriculture and horticulture (Badek *et al.*, 2006). The germination process is characterized by increase in the activity of hormones and enzymes in the seed during the water absorption. By applying biostimulant in the germination process, it is possible to create better conditions for the growth and development of the germ and germination.

The seed that has better germination energy also has better vigor, so it is more resistant to stressful conditions during germination. Biostimulants which containing glucosides (energy grow factors) and amino acids (arginine and asparagine) stimulate root growth and development (rhizogenesis). Biostimulants can be applied in various stages - from sowing seed to transplanting and after transplanting in gardens (Vernieri et al., 2002; Parađiković et al., 2008).

Poincelot (1993) in his research confirm better seed germination, better development of the germ and roots under biostimulant treatment. The aim of this study was to examine germination energy and seed germination of two floral species - *Bellis perennis* L. and *Viola* x *wittrocikana* Gams. under influence of biostimulant Radifarm®.

Material and Methods

Investigation was conducted in laboratory condition at the growing chamber in the Faculty of Agriculture, University of Banja Luka. Flower seeds of *Bellis perennis* L. (manufacturer PanAmerican Seeds) and *Viola x witrocikana* Gams. (manufacturer Benary Quality Seeds)

were used. Also, biostimulant Radifarm® (manufacturer Valagro, Italy), which contains polisaharids, glucosides, proteins, amino acids (arginine and asparagine), vitamins and chelate microelements (Fe and Zn) was used.

Experiment was set up in Petri dishes sterilized with 96% ethanol and lined with filter paper and consisted of control (K) and treatment with biostimulant Radifarm® in two concentrations (T1 0.25% and T2 0.5%). Fifty seeds were counted and placed in Petri dishes on the wet paper. For control group the filter paper was sprayed with 5 ml of distilled water and for treatment with 0.25% or 0.5% of biostimulant Radifarm®. Experiment was set-up in four repetitions for each treatment and each flower species. Prepared Petri dishes with seeds were placed in the growth chamber under an artificial white light for 16h a day and 8h per night. Temperature during the research was constant (20±1°C).

Petri dishes were observed daily and additional water or biostimulant was added if needed. Seeds were kept under these conditions for 14 days. After 7 days germination energy and after 14 days germination of the seeds were tested. Both values are expressed as percentage. The data obtained was statistically analysed (LSD, F-test, t-test) using standard computer programs and VVSTAT (Vukadinović, 1994).

Results and Discussion

Statistically analyzed obtained results of seed germination and germination energy of *Bellis perennis* L. and *Viola x witrocikana* Gams. under influence of biostimulant Radifarm® were separated by the investigated species.

Bellis perennis L.

Comparison by average values of germination energy between the control (K) and treatment with lower biostimulant concentration (T1 0.25%), as well as the control (K) and treatment with higher biostimulant concentration (T2 0.5%) statistical differences were not observed. The highest average values of germination energy of the *Bellis* were recorded in the treatment plants (89.5% T2, 89% T1), while the lowest values were recorded in the control plants (85%). There are not any statistical differences on average values of germination energy between the treatment T1 and T2.

Likewise, average values seed germination of control plant was lower in comparison with average values of both treatments, although the statistical differences were not observed. Also,

there was no observed statistical differences between different biostimulant concentrations. The highest average seed germination values were also recorded in these treatments (93.5% T2, 92% T1), and the lowest in the control group (88.5%) (table 1.).

Table 1. Influence of biostimulant Radifarm® on seed germination and germination energy of *Bellis perennis* L. and *Viola* x *wittrockiana* Gams.

Treatment variant	Repetition	*Bellis perennis* L.		*Viola* x *wittrockiana* Gams.	
		Germination energy %	Germination %	Germination energy %	Germination %
Control K	I	90	96	78	88
	II	86	88	74	82
	III	86	90	76	78
	IV	78	80	68	76
Average		85	88,5	74	81
Tretament T1 (0.25%)	I	96	98	84	88
	II	88	92	86	96
	III	80	82	82	88
	IV	92	96	80	84
Average		89	92	83	89
Tretament T2 (0.5%)	I	86	94	82	86
	II	90	92	86	90
	III	88	92	88	92
	IV	94	96	94	96
Average		89,5	93,5	87,5	91
LSD	0,05	ns	ns	6,5516	7,7629
	0,01	ns	ns	9,4132	ns

Viola x *wittrockiana* Gams.

Statistical analyses of the results show very significant difference between the average values of germination energy for the control plants (K) and treatment with lower biostimulant concentration (T1 0.25%) and control plants (K) and treatment with higher biostimulant concentration (T2 0.5%). The average germination energy of *Viola* seeds in T2 treatment was 87,5%, in T1 treatment was 83% while in control plants 74%.

Average values of the seed germination in both treatment variants were significantly higher than the average values of control plants. No differences in seed germination of *Viola* between lower and higher biostimulant concentration were observed. The highest average values of seed germination was observed in T2 with 91%, while in T1 was 89%. The lowest average values of seed germination were 81% in control plants (K) (table 1.).

Parađiković et al. (2008) confirmed that biostimulant Radifarm® increased the germination energy, seed germination and seedling fresh weight on *Portulaca grandiflora* Hook., *Helichrysum bracteatum* Vent., *Tagetes erecta* L. and *Zinnia elegans* L. Some authors reported that biologically active substances with auxin mixture, humic and fulvic acids could have positive effects on germination. Procházka et al. (2015) confirmed the positive influences of Lexin (which contains auxin, humic and fulvo acids) on germination energy, seed germination of soybean, as well as on development of transplants. All of this has positive influence on productivity of the whole plant. Vinković et al. (2007) confirmed that biostimulant application leads to better germination of old soybean and corn seeds. Yildirim et al. (2002) reported similar stimulating effects on seed germination in an experiment with parsley, celery, and leek seed soaked with a 1% humic acid solution. In the research of Majkowska-Gadomska et al. (2017), ornamental plant species (*Callistephus chinensis*, *Salvia splendens*, *Zinnia elegans*, and *Tagetes patula*) responded differently to tested biostimulants used for seed preconditioning. Zinnia seeds treated with this biostimulant had the highest germination energy.

Positive effects of amino acids, arginine and proline on seed germination, development of lateral roots and cotyledon leaves of salad have been described by Tomić (2012). In addition to amino acids, some biostimulants contain humic acids which have positive influence on germination, development of the roots and above ground parts of the tomato (Thi and Boheme, 2001).

Jevđović et al. (2012) investigated influence of biostimulants Epin Ekstra and Cirkon on yield and quality of *Linum usitatisimum* L. and concluded that the applied biostimulant can improve yield of flax (*Linum usitatisimum* L.) as well as germination energy and seed germination. The benefits of Radifarm® applied at the germination stage show that biostimulants have much potential for use in transplant production. Biostimulants can enhance seed vigor and plant productivity, but to optimize their use, we need to learn a lot about biostimulants themselves, including the chemical composition of commercial products as well as optimal dose and timing, but also about the biochemical processes underlying plant reactions to biostimulant treatment. The available research suggests that particular functional compounds of biostimulants affect seedling, plant growth and development in specific ways, but it is more than likely that their individual compounds interact, resulting in difficult to predict effects without controlled studies (Parađiković et al., 2018).

Conclusion

Based on the obtained results we can conclude that the tretament with a biostimulant can enhance seed vigor and plant productivity in both treatment variants of *Viola* and *Bellis*. In some cases there are no positive effects of the applied biostimulant in Bellis (T1-III and T2-I), because of the strong competitons infected seeds with microorganisms. It is very important to say that the germination energy of *Viola* treated seeds was from 6% to 26% bigger. Seed germination of *Viola* in all of biostimulant treatments was higher except the treatment variant T2-I where germination was 2% lower in compare with the control group.

We can conclude that the biostimulant Radifarm is recomended in this stage of development of *Bellis perennis* L. and *Viola* x *wittrockiana* Gams. Also, we can conclude that obtained effects can be more higher if seeds were constantly treated with some sort of a fungicide.

References

Badek, B., van Duijn, B. & Grzesik, M. (2006). Effects of water supply methods and seed moisture content on germination of China aster (Callistephus chinensis) and tomato (Lycopersicon esculentun Mill.) seeds. *European Journal of Agronomy*, 24(1), 45-51.

Jevđović, R., Filipović, V., Marković, J., Dimitrijević, S., Todorović, G. & Ugrenović, V. (2012). Efekti primene nekih biostimulatora na prinos i životnu sposobnost semena uljanog lana. Društvo selekcionara i semenara, *Selekcija i semenarstvo - Plant breeding and seed production*, 18(2), 41-50.

Majkowska-Gadomska, J., Francke, A., Dobrowolski, A. & Mikulewicz, E. (2017). The effect of selected biostimulants on seed germination of four plant species. *Acta Agrophysica*, 24, 591-599.

Parađiković, N., Vinković, T. & Radman, D. (2008). Utjecaj biostimulatora na klijavost sjemena cvjetnih vrsta. *Sjemenarstvo*, 25(1), 25-32.

Parađiković, N., Teklić, T., Zeljković, S., Lisjak, M. & Špoljarević, M. (2018). Biostimulants research in some horticultural plant species - A review. *Food and Energy Security*, e00162.

Poincelot, P.J. (1993). The use of a commercial organic biostimulant for bedding plant production. *Journal of Sustainable Agriculture*, 99-106.

Procházka, P., Štranc, P., Pazderů, K., Štranc, J. & Jedličková, M. (2015). The possibilities of increasing the production abilitiesof soya vegetation by seed treatment with biologically active compounds. *Plant Soil Environmental,* 61(6), 279–284.

Thi, L. & Bohme, H. (2001). Influence of humic acid on the growth of tomato in hydroponic systems. *Acta Horticulturae,* 548, 451-458.

Tomić, O. (2012). *Klijavost sjemena kres salate nakon tretmana biljnim ekstraktima*. Diplomski rad - Sveučilište Josipa Jurja Strossmayera, Poljoprivredni fakultet Osijek.

Vernieri, P., Malorgio, F. & Tognoni, F. (2002). Use od biostimulants in production of vegetable seedlings. *Colture-Protette*: Rome.

Vinković, T., Parađiković, N., Plavšić, H., Grubec, V. & Levai, L. (2007). Maize and soybean seed vigour under influence of seed age, seed treatment and temperature in cold stress test. *Cereal Research Communications*: 1213-1216.

Vukadinović, V. (1994). *VVSTAT - računalni program za statističku obradu podataka*. Poljoprivredni fakultet Osijek.

Yildirim, E., Dursun, A., Guvenc, I. & Kumlay, A.M. (2002). The effects of different salt, biostimulant and temperature levels on seed germination of some vegetable species. *Acta Agrobotanica,* 56, 75-80.

Original scientific paper

Chemical composition of milk as an indicator of nutritional state of cows

Đorđe Savić[1], Stoja Jotanović[1], Miroslav Borojević[2], Marinko Vekić[1], Zora Čolović-Šarić[1]

[1] University of Banja Luka, Faculty of Agriculture, Republic of Srpska, Bosnia and Herzegovina

[2] MMB Inex Coop, Šamac, Republic of Srpska, Bosnia and Herzegovina

Corresponding author: Đorđe Savić, djordje.savic@agro.unibl.org

Abstract

The aim of the study was to evaluate the nutritional state of cows at the farm level, based on the results of the analysis of the chemical composition of the milk. A total of 94 cows in different phases of lactation, kept and fed in standard farm conditions were examined, and milk samples were taken within the framework of regular productivity control carried out by the selection service. Milk fat and protein concentrations were determined on the Bentley 150 Infrared Milk Analyzer, and urea concentration on the Bentley Chemspec150 Urea Analyzer for Milk. The average concentrations of milk fat, protein and urea were 4.22±0.73%, 3.51±0.40%, 2.51±0.62 mmol/l (15.05±3.73 mg/dl) and the average value of fat to protein ratio was 1.21±0.20. The results of this study show that the cows on the farm are adequately supplied with energy and proteins, that the structure of the ration was satisfactory, so it can be concluded that the cows on examined farm are fed well which reflects favorably on the manifestation of their genetic potential for milk yield, but also to preserve their health, reproductive abilities and prolong their exploitation period.

Key words: nutritive state of cows, chemical composition of the milk

Introduction

Milk is synthetised in the milk gland from ingredients that reach it through blood, and therefore the composition of milk is a reflection of the composition of blood and the health condition of

the milk gland. In this sense, the chemical composition of milk, concentrations and the ratios of its constituents can be a reliable indicator of cows' nutritional status (Čuklić et al.; 2009, Savić et al., 2010, 2011).

Lower fatty acids are formed as the ultimate product of decomposition of carbohydrates in rumen, and their relationship is directly dependent on the composition of the ration. When cows are fed with forage-based ration, more acetic acid is produced, while usage of ration dominantly based on concentrates results in the formation of a higher amount of propionic acid. Acetic acid is used as a milk fat precursor, while propionic acid serves as a precursor of glucose (Stojić, 2007; Matarugić and Savić, 2008). The enhanced synthesis of acetic acid is base of a slightly higher concentration of milk fat in milk during the winter feeding period. During the summer feeding period with a higher amount of green forage, a decrease in milk fat concentration can be observed, similarly as when the ration contains a higher proportion of concentrates (Šamanc et al., 2006; Grubić et al., 2007). Except the nutrition, the concentration of milk fat depends also from a number of other factors, such as cow age, lactation stage, body condition of cows, and milk sampling as an important factor at the level of individual milking. (Savić et al., 2010, 2011, Kirovski et al., 2012).

Ruminal microorganisms are able to bind non-protein nitrogen, primarily from ammonia produced by amino acids desamination, and incorporate it into their own proteins, whereby they require energy for that activity (Grubić and Adamović, 2003). This ability is the basis for the use of non-protein nitrogen sources of in ruminant nutrition, and at the same time the basis for estimating the supply of cows with energy and proteins through ration, their mutual relationship, and the usefulness of raw proteins (Čuklić and Kalember, 2004; Šamanc et al., 2006; Savić et al., 2010, 2011; Glavić et al., 2013). If the ration is insufficient in protein content, if it has an unfavorable ratio of rumen degradable and non-degradable proteins, or if is not adequately balanced in energy-protein ratio, the concentration of protein in milk decreases below the physiological limit of 32 g/l. Increasing protein concentration in milk can be seen if the ration contains a high percentage of proteins, if the milk contains colostral immunoglobulins, as well as in the final lactation phase, when the milk is "thickened" (Kirovski et al., 2012, 2013; Mijatović, 2014).

Ammonia that is not used by the ruminal microorganisms is absorbed through the ruminal, detoxicated in liver into urea, and then secreted through urine, saliva and milk (Broderick and Clayton, 1997). If there is insufficient ammonia binding in rumen, the concentration of urea in the blood and milk is elevated, which may be an indicator of an inadequate relation between energy and protein in ration (Čuklić and Kalember, 2004; Gantner et al., 2006; Kirovski et al.,

2012). The concentration of urea in the blood and milk depends on the composition of the ration, the annual season, the body condition and age of the cows, and the stage of lactation (Westwood et al., 1998; Savić et al., 2014). Urea concentration values in milk below 4.0 mmol/l and proteins above 32.0 g/l indicate an adequate supply of energy and proteins through ration. If there is a decrease in the energy value of the ration, the concentration of urea in milk is increased above this limit, initially with the preserved protein concentration. In a situation of marked deficiency of energy and decreased activity of the ruminal microorganisms, the concentration of urea in milk is increased, between 5 and 10 mmol/l, and the milk protein concentration decreases below 30 g/l (Rajčević et al., 1997; Kampl, 2005; Savić and sar., 2010, 2011). If there is a decrease in milk urea and protein concentrations below the physiological value, the most likely cause is the primary - absolute protein deficiency in the ration. In practice, different combinations of urea and protein concentrations in milk can be seen, from absolute deficiency or surplus of energy and/or protein, to a relative deficit or surplus of one or the other, which is best seen in graphical representations of urea and protein in milk relation (Savić et al. 2010, 2011; Kirovski and sar., 2012, 2013).

Insights into the energy and nutritional status of cows can also be derived from the relationship between the concentration of milk fat and protein (Jovanovac et al., 2007). An elevated concentration of milk fat above the physiological limit often indicates the existence of a negative energy balance and lipomobilization, especially in early lactation. Critical values are the concentration of milk fat over 45 g/l and protein concentration below 32 g/l, and FPR (milk fat to protein ratio) values above 1.5 and below 1. Increased value of FPR can be seen most often at the beginning of lactation, when there is lipomobilization and decrease in concentration protein in milk due to reduced food intake present, or in the late lactation, when milk is "thickened", due to decrease in milk yield. The reduction in FPR value can be seen when the content of raw fiber in the ration is insufficient, most often in the initial lactation phase, when farmers try to compensate for energy deficits due to rising energy needs and reduced food intake by giving cows higher amounts of concentrates (Savić et al., 2011; Kirovski et al., 2012). When interpreting the results of the ratio of milk fat and protein in milk, it is necessary to take into account the stage of lactation, the ration composition, breed differences and other factors, so the results should be considered assuming the overall state of cows (Savić et al., 2010, 2011, 2014).

Bearing in mind the importance of the structure of the ration, or the content of raw fibers, for proper digestion in ruminants, it is necessary that the ration has adequate structure, in order to fulfill the rumen and mechanically stimulate motility and secretion of digestive organs. The

composition of milk can be a good indicator of the structure of the ration and supply of raw proteins and energy, through the relationship between FPR and milk protein and milk urea and protein content, which is best seen in the graphic representations of their mutual relations (Babnik et al., 2004). Assuming all mentioned, the aim of the study was to evaluate the nutritional state of cows at the farm level, based on the results of the analysis of the chemical composition of the milk.

Material and Methods

The study was conducted on the dairy farm "MMB Inex COOP" Samac, in November 2016. A total of 94 cows in different stages of lactation, included in the program of productivity control, were tested. The estimated average weight of the cow ranged between 500 and 600 kilograms, and the herd included Simmental, Holstein-Friesian cows, and their crosses with the Norwegian red. All cows were kept in a free hold system and fed by the usual rations for a given category, period of the year and the lactation phase. The milk samples were taken during regular milking within regular productivity control. The concentrations of milk fat, protein, lactose and dry matter was determined in the laboratory for the control of raw milk, on the Bentley 150 Infrared Milk Analyzer, and the urea concentration on the Bentley Chemspec150 Urea Analyzer for Milk. The results were processed by standard statistical methods and presented in a tables and graphs.

Results and Discussion

Data on the concentration of organic milk ingredients and their mutual relations in examined cows are shown in Table 1.

Table 1. Concentration of organic milk ingredients, and their mutual relations in examined cows (n = 94)

Parameter	M	SD	SE	IV	CV (%)
Milk fat (%)	4,22	0,73	0,08	2,05 - 6,36	17,27
Proteins (%)	3,51	0,40	0,04	2,42 - 4,75	11,37
Fat to protein ratio (FPR)	1,21	0,20	0,02	0,69 - 1,82	16,26
Urea (mg/dl)	15,05	3,73	0,38	7,30 - 21,60	24,78
Urea (mmol/l)	2,51	0,62	0,06	1,22 - 3,60	24,78

M – mean; SD - standard deviation; SE – standard error; IV – interval of variation; CV – coefficient of variation

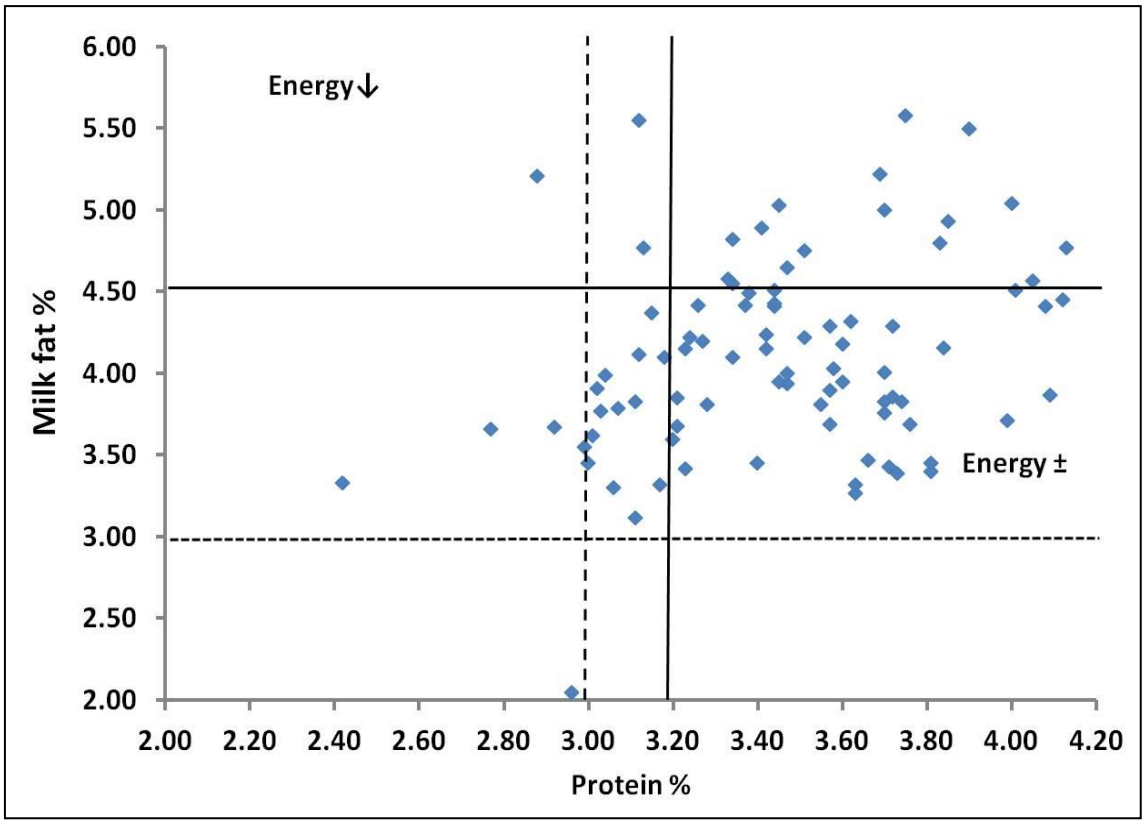
The data shown in Table 1 indicate that the average milk fat concentration was higher than the average values reported in the literature (36-40 g/l, or 3.6 to 4.0%, according to Kirovski et al., 2012), but still within the limits of physiological values. Savić et al. (2010) found lower value for the concentration of milk fat in Holstein breed cows, while the same authors in later study (Savić et al., 2011) found values closer to results of this study. Kitonjić (2014) monitored the concentration of milk fat in Simmental cows in the first three lactations and found values of 37.76 g/l (3.78%), 41.30 g/l (4.13%) and 42.15 g/l (4.22%), for cows of the first, second and third lactation, respectively. Low milk fat syndrome was described by Šamanc et al. (2006), who found concentrations of milk fat of 16.6 g/l and 10.7 g/l on two of the four tested farms, while on the other two farms values of 38.9 g/l and 33.8 g/l were found, which is within physiological limits.

The protein content in milk is an indicator of cow's supply of protein from the ration, as well as their biological availability and the degree of their degradation and synthesis in the moon. The average milk protein concentration was 3.51%, which is within the physiological values indicated in the literature (protein content higher than 3.2%, according to the data given by Savić et al., 2010, 2011, Kirovski et al., 2012, indicate that cows are adequately supplied to proteins through ration). The results of this study are in accordance with the results of Kitonjić (2014), who found concentrations of milk protein of 35.91 g/l, 35.37 g/l and 36.18 g/l for Simmental cows in the first, second, or third lactation, respectively. Savić et al. (2010, 2011) found protein concentrations below the optimum values, and lower compered to results of this study, and attributed it to the use of large amounts of green forage, insufficiently balanced in energy and protein content. Šamanc et al. (2006) found milk protein concentrations in the range of 26.9 g/l to 30.5 g/l on four dairy farms, which is lower than those found in this study, and indicate inadequate supply with protein through ration.

The milk fat to protein ratio (FPR) is a result of their concentrations and physiologically ranges from 1 to 1.3. Average FPR value in this study was 1,21, and can be marked as in physiological range, but its variations (from 0.69 to 1.82) indicate there were cows with possible lipomobilisation, and those with possible subacute ruminal acidosis. This range of FPR values can also be attributed to stage of lactation, as an important factor that can influence FPR value (Savić et al., 2014).

In this study, an average urea concentration of 2.51 mmol/l, or 15.05 mg/dl, was found, indicating good utilisation of the protein, and a favorable relationship between energy and protein in the ration. In order to establish the distribution of individual cows in relation to the average of the herd, as well as the overall nutritional status of the examined cows, the obtained

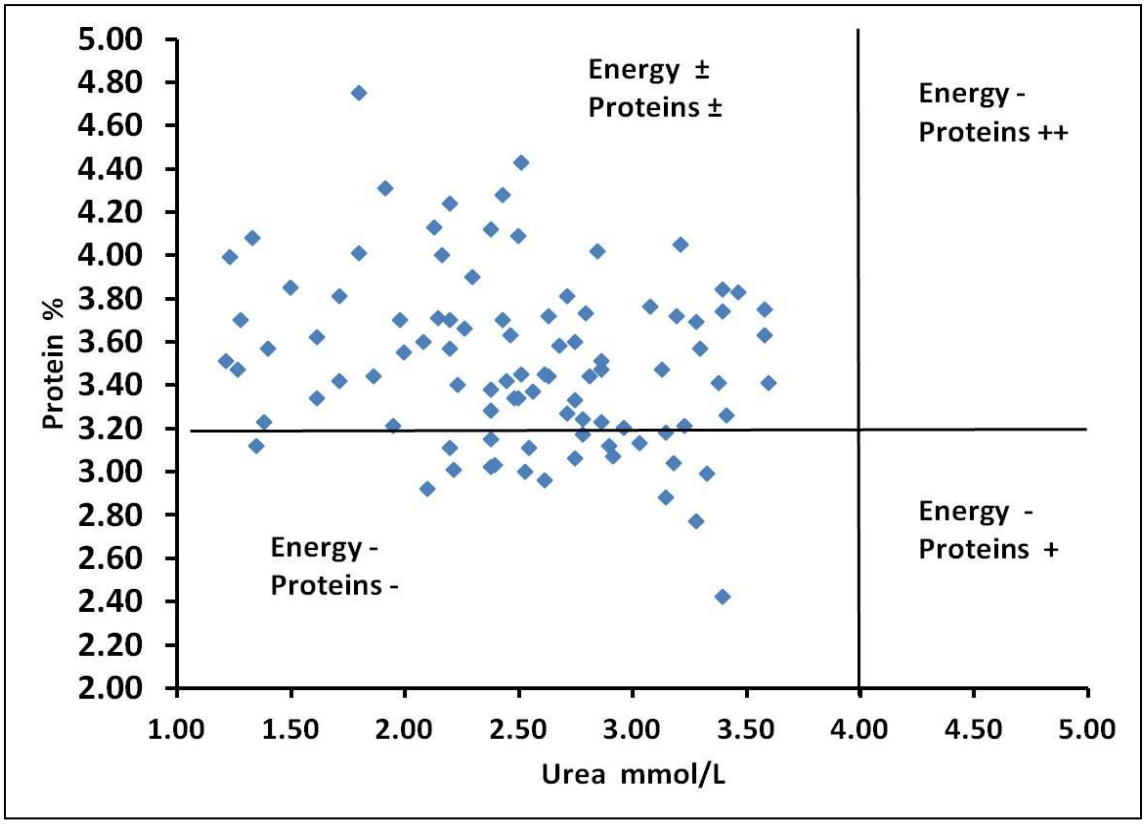
results are presented graphically. The relationship between the concentrations of milk fat and protein, and urea and protein in the milk of the examined cows is shown in Charts 1 and 2.



Graph 1. Relation of milk fat to protein in milk of examined cows

The data shown in Chart 1 indicate that the majority of examined cows had a milk fat concentration below 4.5% and a protein concentration of over 3.2%, indicating good energy and protein supply through ration. In only a few cows, values of protein concentration below 3.0% were found, indicating inadequate protein supply.

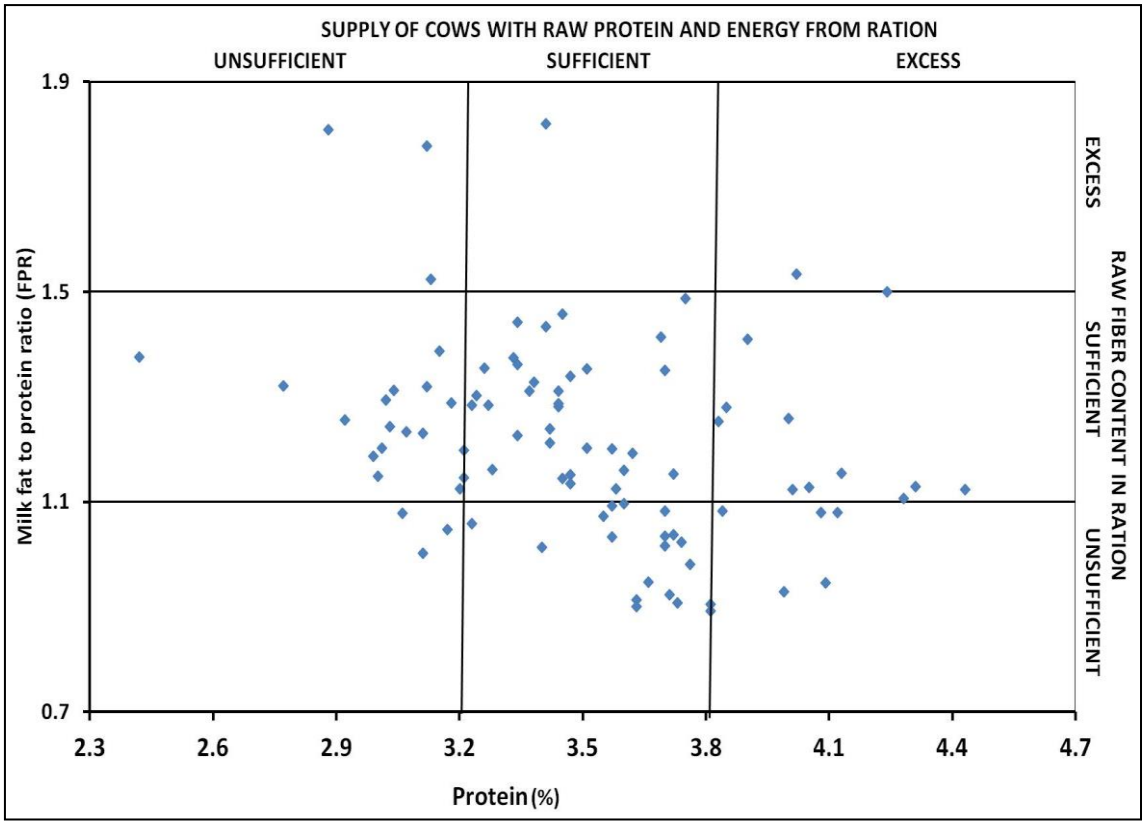
A similar situation is with a few cows in which the concentration of milk fat above the limit of 4.5% was found, indicating the possible presence of the lipomobilization process and development of metabolic disorders.



Graph 2. Relation of urea and protein in milk of examined cows

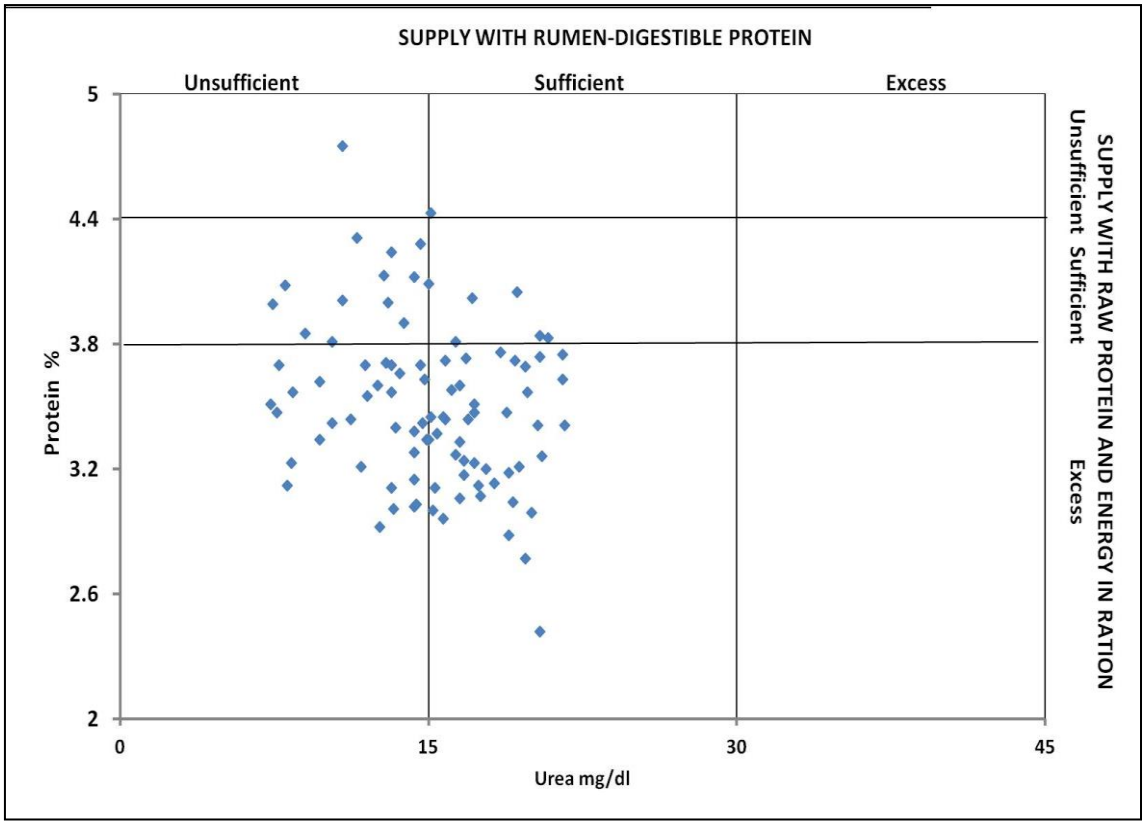
The data shown in Figure 2 indicate that the urea concentration was below 4 mmol/l in all examined cows and the protein concentration was above 3.2% for almost all cows, which indicates a favorable relationship between energy and protein in the cows' ration. Low concentration of urea in the milk of the examined cows indicate that ruminal microorganisms were well supplied with energy, and were able to "capture" a large amount of ammonia released during digestion of proteins from the ration, to bind it and embed it into their amino acids and proteins, which were later digested in the intestines and from which milk proteins were synthesized. High protein content in milk of the examined cows indicates good supply of proteins through ration, and also high level of their utilisation.

Structure of the ration is an important element for the adequate utilization of nutrients from the cows' ration and the proper functioning of the rumen. The insight into the structure of the ration and supply of energy and digestible proteins can be made on the basis of ratio of FPR and milk protein concentration, and the ratio of milk urea to protein content. The distribution of examined cows in relation to the structure of the ration and the utilization of proteins available is given in Charts 3 and 4.



Graph 3. Supply with raw protein and energy and structure of ration in examined cows

The data presented in Chart 3 indicate that the supply of raw proteins and energy was satisfactory in most of the examined cows, as indicated by their position within the chart. In a few cows, insufficient or excessive supply of raw proteins and energy was found, which is probably the result of the influence of the lactation stage and daily milk yield, and certainly the characteristics of each cow breed included. The structure of the ration in terms of the raw fiber content was satisfactory most of cows, ie the ration contains a sufficient amount of cellulose that stimulates the digestion and motility of the digestive organs, and thus the utilization of nutrients available. Of course, there are variations and minor deviations from the group average found, which can be attributed to the lactation stage and daily milk yield, as well as the individual feed consumption.



Graph 4**.** Utilisation of protein from ration in examined cows

The data presented in Figure 4 indicate a high degree of protein utilization from ration, given the low content of urea and the high content of protein in milk. The largest number of tested cows were supplied with digestible proteins to a satisfactory extent, as indicated by their position within the chart. For a number of cows, the supply of digestible proteins looked like insufficient, as the milk urea concentration was below the limit of 15 mg/dl. However, when taking into account the milk protein concentration, supply of raw proteins and energy, it can be concluded that the energy supply of the examined cows through ration was such that it allowed the microorganisms to use almost all the ammonia created in the rumen and incorporate it into their own proteins, which is why the synthesis of urea in the liver, and consequently its concentration in milk was lowered below the limit of 15 mg/dl.

Conclusion

The graphical presentations of the relationship between the individual organic components of the milk, shown in this paper, can provide a reliable insight into the nutritive status of cows, both at the individual and at the herd level, which enables the identification of omissions in the ration composition, its correction and optimization, but also to monitor the effects of the

applied measures. In this way, continuous monitoring of the herd nutritional status is ensured, and thus the creation of measures for better usage of the genetic potential of cows. Timely detection of the cows with values of these parameters outside the physiological framework, potentially with subclinical health disorders, together with the analysis of information on breed, lactation state, nutrition and other relevant information, enables the farmer, veterinary and advisory service to take the necessary therapeutic and preventive measures, in order prevent the occurrence of clinically manifest disorders of cow health. In addition to its influence on the milk production and prevention of health disorders, monitoring of the nutritional status of cows in this way indirectly contributes to improving the reproductive performances of cows, as well as to the prolongation of their productive life, and thus to achieving a better economic effect for the producer.

References

Babnik, D., Verbič, J., Podgoršek, P., Jeretina, J., Perpar, T., Logar, B., Sadar, M. & Ivanovič B. (2006). *Priročnik za vodjenje prehrane krav molznic ob pomoči rezultatov mlečne kontrole*. Kmetijski Institut Slovenije, Ljubljana.

Broderic G.A. & Clayton M.K. (1997). A statistical evaluation of animal and nutritional factors influencing concentration of milk urea nitrogen, *J Dairy Sci,* 80, 2964-2971.

Čuklić, D., Vukobratović, M., Poljak, F.T., Đuranec, V., Pintić, N. & Jelen, T. (2009). Korišćenje kemijskih analiza mlijeka u menadžmentu hranidbe mliječnih krava, *Krmiva*, 51, Zagreb, 1, 37-44.

Čuklić, D. & Kalember, Đ. (2004). Urea u mlijeku kao parametar hranidbe mliječnih krava, *Stočarstvo*, 58 (1), 3-13.

Gantner, V., Kuterovac, K., Jovanovac, S., Solić, D. & Dakić, A. (2006). Vrednovanje hranidbenog statusa mliječnih krava na osnovu sadržaja bjelančevina i ureje u mlijeku, *Stočarstvo*, 60 (1), 41-45, Opatija.

Glavić, M., Tumpej, I., Zenunović, A. & Hasić, A. (2013). *Upravljanje ishranom muznih krava pomoću rezultata mliječne kontrole*. Program razvoja tržišne poljoprivrede (FARMA), Sarajevo.

Grubić, G. & Adamović, M. (2003). *Ishrana visokoproizvodnih krava*. Institut PKB Agroekonomik, Beograd.

Grubić, G., Đorđević, N. & Stojanović, B. (2007). *Uticaj obroka na smanjenje mliječne masti*. Zbornik naučnih radova, 13 (3-4), 21-32.

Jovanovac, S., Gantner, V., Raguž, N., Kuterovac K. & Solić D. (2007). Omjer mliječne masti i bjelančevina kao indikator hranidbenog statusa holštajn krava pri različitom stadiju i redoslijedu laktacije, *Krmiva*, 49, Zagreb, 4, 189-198.

Kampl, B. (2005). *Pokazatelji energetskog deficita mlečnih krava u mleku i njihovo korišćenje u programu zdravstvene preventive i intenziviranja proizvodnje i reprodukcije, Etiopatogeneza i dijagnostika poremećaja metabolizma i reprodukcije goveda*. Zbornik radova, Subotica, 261-267.

Kirovski, D., Šamanc, H. & Prodanović, R. (2012). Procjena energetskog statusa krava na osnovu koncentracije proteina i ureje u mlijeku. *Vet. glasnik*, 66 (1-2), 97-110.

Kirovski, D., Šamanc, H., Sladojević, Ž., Prodanović, R. & Vujanac, I. (2013). Nutritivni status visokomliječnih krava, procjena na osnovu sastava mlijeka. *Veterinarski žurnal Republike Srpske*, Vol. XIII, br/No. 2, 109-116.

Kitonjić, Jelena (2014). *Sadržaj mliječne masti i proteina kao indikator nutritivnog statusa krava*. Završni rad. Univerzitet u Banjoj Luci, Poljoprivredni fakultet.

Matarugić D. & Savić Đ. (2007). *Fiziologija domaćih životinja*. Univerzitet u Banjoj Luci, Poljoprivredni fakultet Banja Luka.

Mijatović, R. (2014). *Reproduktivne performanse krava sa različitim odnosom sadržaja masti i proteina u mlijeku do uspostavljanja gravidnosti*. Doktorska disertacija. Poljoprivredni fakultet, Novi Sad

Rajčević M., Zadnik T., Levstek J. &Vidio A. (1997). Odraz ljetne hranidbe krava na neke parametre mlijeka i krvi. *Krmiva*, 39 (6), 287-297.

Savić, Đ., Jotanović, S., Pračić, N., Vekić M. & Omanović, H. (2014). Koncentracije organskih sastojaka mlijeka i njihov odnos tokom različitih perioda standardne laktacije. *Radovi Poljoprivredno – prehrambenog fakulteta*, Univerziteta u Sarajevu, 64/2, 101-114.

Savić Đ., Kasagić D., Jotanović S., Matarugić D., Šarić M. & Mijatović R. (2011). Procjena energetskog statusa krava u ranoj laktaciji na osnovu određivanja organskih sastojaka mlijeka, *Agroznanje*, 67-74.

Savić, Đ., Matarugić, D., Delić, N., Kasagić, D. & Stojanović, M. (2010). Određivanje organskih sastojaka mlijeka kao metoda ocjene energetskog statusa mliječnih krava. *Vet. glasnik*, 64 (1-2), 21-32.

Stojić, V. (2007). *Veterinarska fiziologija*. Naučna KMD, Beograd.

Šamanc, H., Kirovski, D., Dimitrijević, B., Vujanac, I., Damjanović, Z. & Polovina, M. (2006). Procjena energetskog statusa krava u laktaciji određivanjem koncentracije organskih sastojaka mleka. *Vet. glasnik*, 60 (5-6), 283-297.

Westwood, C. T., Lean, I. J. & Kellaway, R. C. (1998). Indications and implications for testing of milk urea in dairy cattle, Dietary protein sources and metabolism. *New Zeland Vet J*, 46, 87-96.

Original scientific paper

The effects of ration size on condition factor and length-weight relationship of the brown trout (*Salmo trutta* m. *fario*)

Nebojša Savić[1], Jerko Pavličević[2], Branko Glamuzina[3]

[1]*University of Banja Luka, Faculty of Agriculture, Bulevar vojvode Petra Bojovića 1A, Banja Luka, Bosnia and Herzegovina*

[2]*University of Mostar, Faculty of Agriculture and Food Technology, Biskupa Čule bb, Bosnia and Herzegovina*

[3]*University of Dubrovnik, Department for Aquaculture. Ćira Carića 4, Dubrovnik, Croatia*

Corresponding author: Nebojša Savić, nebojsa.savic@agro.unibl.org

Abstract

The effects of ration size on condition factor and weight-length relationship of brown trout (*Salmo trutta* m. *fario*) were investigated in the laboratory conditions during 42 days. The experiment included two groups with 3 replicates, and was realized in the six flowing aquariums. The one group included 12 fish/aquarium in 3 repetitions (36 fish/group), the total number of the fish in 2 groups was 72 brown trout. The average individual weight (W) ± standard deviation (SD) and total body length, (TL) ± standard deviation (SD) of brown trout was similar and it was in G_{100} 75.72±10.94 and 18.58±0.74 and in G_{80} it was 75.22±9.77 and 18.52±0.83. Both groups were fed with the same commercial diet. Daily nutrition norm for brown trout in G_{100} was 100% and in G_{80} 80% according to nutrition tables recommended by manufacturers of the feed used. Length-weight relationship of the brown trout in G_{100} was calculated as $W = 0.004295L^{3,357}$ (positive allometric growth) and G_{80} was $W = 0.028576L^{2,714}$ (negative allometric growth), while the correlation coefficient (r) in G_{100} and G_{80} was 0.907 and 0.870. Condition factor (CF) ± standard deviation (SD) in G_{100} and G_{80} was 1.25±0.05 (min 1.18; max 1.29) and 1.23±0.04 (min 1.18; max 1.26) on average. Fish with lower daily nutrition norms have negative allometric growth and lower condition factor if compared to higher daily intake.

Key words: Ration size, condition factor, length-weight relationship, brown trout (*Salmo trutta* m. *fario*)

Introduction

Brown trout (*Salmo trutta* m. *fario*) is an important sport fishery species of mountain rivers (Fisher & Burroughes 2003), which is mostly cultivated for the production of juveniles used in fish stocking practice. It has slower growth in cultivating conditions than dominantly cultivated salmonid species, such as rainbow trout, *Oncorhynchus mykiss* and for that reason it's less commonly cultured to market size. The analysis of the length-weight relationship and the condition factor of the brown trout in the natural conditions is frequent, as this determine the growth and regression of these two measures, that is, the degree of correlation between the growth of length and body weight depending on the available feed. Length-weight relationship and condition factor of the brown trout from open waters were reported by the different authors (Arslan et al., 2004; Rechulicz, 2010; Rawat et al., 2014; Tanir & Fakioğlu, 2017; Muddasir et al., 2018 etc.). Values of the exponent b provide information on the fish growth (Sangun, 2007). It has been confirmed that the expected range of regression coefficient (b) is in most fish $2.5 < b < 3.5$ (Froese, 2006). The increase in mass is isometric when $b = 3$, if the value of b is different from 3, the mass increase is allometric, the allometric value is positive if $b > 3$, the allometric value is negative if $b < 3$ (Sangun, 2007). The condition factor is also based on the weight and length relationship. Feeding brown trout in captivity is fully based on factory feed, and proceeds from the assumption that the growth of length and weight is good, if the good conditions of the breeding environment and nutrition is provided. The feeding in culture is commonly carried out in unequal quantities of feed for various reasons, which reflects on the growth of body length and weight, as well as the condition factor of the cultivated brown trout. Lans et al. (2011) investigated the effects of different meal sizes on increasing the migration rates of Atlantic salmon, *Salmo salar* and brown trout and found that it was possible to use a daily meal by less than 15-20%.

The aim of this study was to determine the effects of ration size on length-weight relationship and condition factor of brown trout (*Salmo trutta* m. *fario*).

Material and Methods

The study on the effects of ration size on length-weight relationship and condition factor of brown trout (*Salmo trutta m. Fario*) was carried out in laboratory conditions for 42 days. The experiment included 2 groups with 3 replicates, and was realized in 6 flowing aquariums. One group included 12 fish/aquarium in 3 repetitions (36 fish/group), the total amount of fish in 2

groups was 72 brown trout. The average individual weight, g (W) ± standard deviation (SD) and total body length, cm (TL) ± standard deviation (SD) of brown trout was similar and it was in G_{100} 75.72±10.94 and 18.58±0.74 and G_{80} 75.22±9.77 and 18.52±0.83. The brown trout was fed with the same, commercial diet, with a different of ration size. The daily nutrition norm of brown trout in G_{100} was 100%, according to recommended nutrition tables from the manufacturer, while in G_{80} they were fed with 80% of daily feed amount according to recommended nutrition tables from the manufacturer of feed used. Feed used in the experiment had: crude protein 42%, crude fats and oils 26%, fiber 3%, ash 4.5%, phosphorus 0.8% and digestible energy 20.0 MJ / kg. Total length and body weight were measured at the beginning and at intervals of 14 days until the end of the study. After determining the length and weight of the body, daily feed norms were determined based on the recommended feeding tables of the feed manufacturer. The total length (cm) of each fish was taken from the tip of the snout to the longest tip of the caudal fin was measured with an ihtiometer (0.1 cm precision), and the individual mass with a Acculab scale (0.1g precision), 4800 g load capacity. During the experiment, water temperature, dissolved oxygen and pH of the water were measured. Water temperature and dissolved oxygen content in the water were measured with an oximeter (Oxi 330i/SET 2B20–0011 WTW Germany), and pH value with a pH-meter (pH 330i/SET 2A20–1011 WTW Germany).

Fulton's condition factor was calculated with the following formula:

$$CF = (BW/L^3)*100$$

where: BW - body weight (g), L - total length (cm).

Length-weight ratio was determined using an exponential function

$$W = aL^b$$

Where:
W – weight (g); a = constant; b = regression coefficient; L = total length (cm).

Transformed into logarithmic form:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

The equation of linear regression:

$$y = a + bx$$

where:
y – dependent variable; x -independent variable; a – regression constant; b – regression coefficient.

Statistic program SPSS17 was used for determining descriptive statistic and linear regression parameters.

Results and Discussion

The results of the water temperature measurements, dissolved oxygen and pH values during the experiment indicate a similar water quality in experimental groups (table 1.).

Table 1. Water analysis results

Group	Water temperature °C			Dissolved O_2 (mg/l) in the water			pH of the water		
	Min	Max	Average±SD	Min	Max	Average±SD	Min	Max	Average±SD
G_{100}	14.10	16.50	14.94±0.43	7.69	8.59	8.13±0.19	7.13	7.34	7.22±0.07
G_{80}	14.20	16.00	15.03±0.39	7.47	8.71	8.19±0.24	7.19	7.59	7.29±0.11

To determine the length-weight relationship of the brown trout, the total lengths and weights of all individuals were used. Table 2 shows the variation limits (minimum and maximum values) of total length (cm) and individual body weight (g) of brown trout in groups G_{100} and G_{80} with different ration size.

Table 2. The range of variation of the total length (cm) and individual body mass (g) of brown trout per days

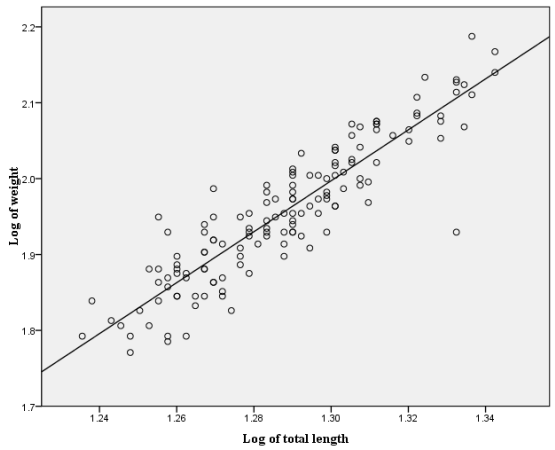
Days	N	**G_{100}**				**G_{80}**			
		TL (cm)		W (g)		TL (cm)		W (g)	
		Min	Max	Min	Max	Min	Max	Min	Max
0	36	17.2	20.4	59.0	101.0	16.4	20.5	58.0	107.0
14	36	17.8	21.3	62.0	118.0	17.0	20.6	67.0	107.0
28	35	17.9	21.6	73.0	136.0	17.5	21.2	68.0	120.0
42	35	18.5	22.0	85.0	154.0	18.7	22.5	83.0	141.0

Results of the logarithmic values of total length and body weight indicate a positive allometric growth in G_{100} ($b > 3$), with a coefficient of correlation (r) length and body weight 0.907 and a coefficient of determination of 0.823. The G_{80} is characterized by a negative allometric growth ($b < 3$), with a coefficient of correlation (r) length and body weight 0.870 and a coefficient of determination of 0.757, which is a consequence of lower daily ration for individuals in this group.

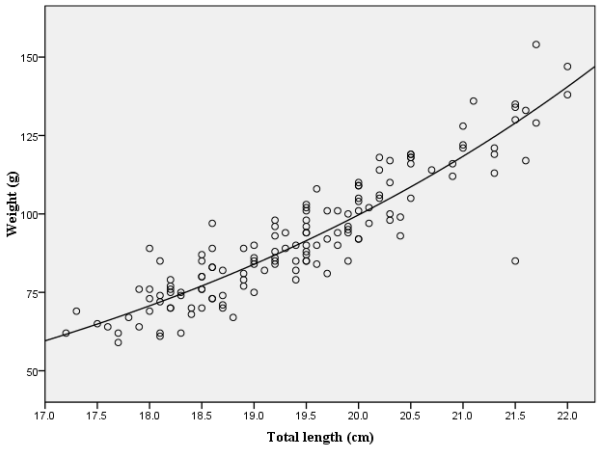
Table 3. Logarithmic values of total length and weight, regression coefficients, correlation and determination coefficient of brown trout *Salmo trutta* m. *fario*

Group	Log TL			Log W			Regression parameters		R	r^2
	Min	Max	Average±SD	Min	Max	Average±SD	a	b		
Log G_{100}	1.24	1.34	1.29±0.02	1.77	2.19	1.96±0.09	-2.367	3.357	0.907	0.823
Log G_{80}	1.21	1.35	1.29±0.03	1.76	2.15	1.95±0.08	-1.544	2.714	0.870	0.757

The equation of the length-weight relationship of the brown trout in G_{100} is $W = 0.004295L^{3,357}$, logarithmic form is *Log*W=-2,367+3,357*Log*L and linear regression equation y=-2.367+3.357x. The equation of the length-weight relationship of the brown trout in G_{80} is $W = 0.028576L^{2,714}$, logarithmic form is *LogW*=-1.544+2.714*Log*L and linear regression equation y=-1.544+2.714x. Determined positive (G_{100}) and negative (G_{80}) allometric growth indicated dependence of the growth on the conditions of the environment in which the brown trout is cultivated and the available quantities of feed for its nutrition. According to Nishikant and Motilan (2015) the length- weight relationship of fish depends on the conditions in which the fish is grown. Research conducted in Eastern Turkey Arslan et al. (2004) determined the negative allometric growth of brown trout during the winter period when there is not enough feed and the abiotic conditions of the environment are not satisfactory, while in the rest of the year normal isometry is present, with both males and females having similar growth.

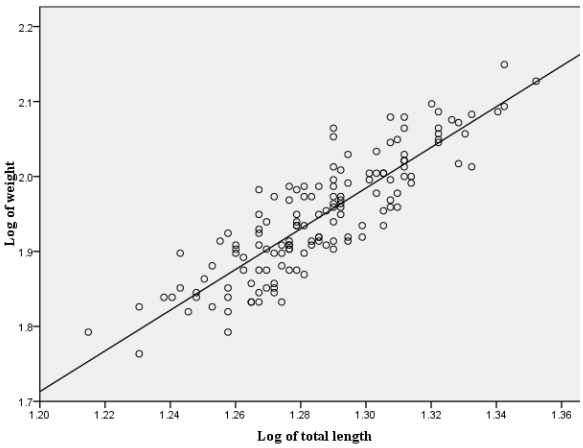


Graf. 1. Logarithmic values of length and weight of *Salmo trutta* m. *fario* in group G_{100}

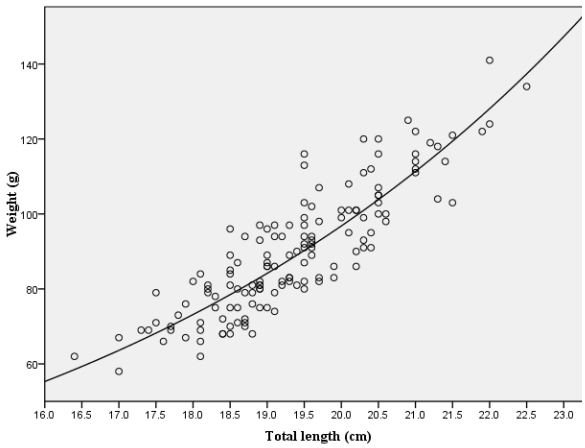


Graf. 2. Length-weight relationship *Salmo trutta* m. *fario* in group G_{100}

The results of the study indicate a positive correlation of the length and weight of the brown trout body in the experiment (0.907 and 0.870), lower than reported by Ravat et al (2014), which investigated the length-weight relationship and the condition factor of the brown trout (*Salmo trutta fario* L.) in the Asiganga River (India) and established a high degree of positive correlation between the length and weight of the brown trout (r = 0.985).

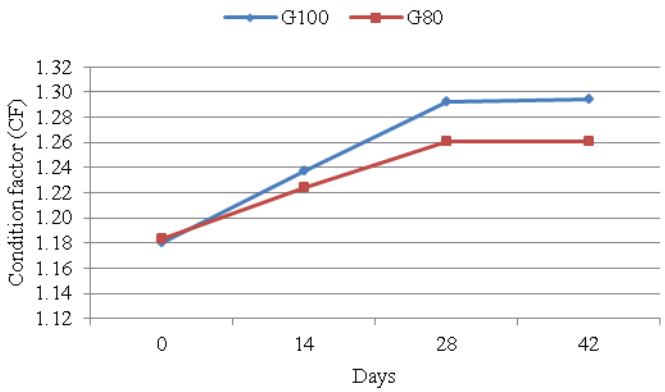


Graf. 3. Logarithmic values of length and weight *Salmo trutta* m. *fario* in group G_{80}



Graf. 4. Length-weight relationship of *Salmo trutta* m. *fario in group* G_{80}

The condition factor was satisfactory in both groups with a higher value in the G_{100}, and a positive relationship was established between fed and condition factor in accordance with Lans et al (2011). The condition factor (CF ± SD) in the G_{100} was 1.25 ± 0.05 (min 1.18; max 1.29) and in G_{80} at an average of 1.23 ± 0.04 (min 1.18; max 1.26), which was within the required range and indicated good condition of brown trout. Rechulicz (2010) and Trozic-Borovac (2002) stated that the condition factor of brown trout from two rivers in Poland and the Una River in Bosnia and Herzegovina (similar sizes) was 1.08 (min 0.49; max 1.53) and 1.09 (min 1.0; max 1.59). Ravat et al (2014) stated that the condition factor of brown trout from the Asigang River in the winter period was 1.473±0.694 in males and in females 1.357±0.210. Muddasir et al (2018) stated that the condition factor of the studied brown trout was above 1, indicating the robustness or welfare of the experimental fish.



Graph 5. Condition factor (CF) of brown trout by control periods

Initially, the condition factor (CF) in the observed groups was the same, and from Chart 5. it is visible that the difference of the condition factor between the observed groups is already present from the first control.

Conclusion

The regression coefficient in G_{100} was 0.907, and the coefficient of determination is $r^2 = 0.823$, while for G_{80} it was 0.870, and the coefficient of determination is $r^2 = 0.757$. The length-weight relationship of the brown trout in the G_{100} was calculated as $W = 0.004295L^{3.357}$ (positive allometric growth) and G_{80} is $W = 0.028576L^{2.714}$ (negative allometric growth). With the brown trout fed with 80% of the daily meal (G_{80}), negative allometric growth was determined (b = 2.714), unlike the brown trout in G_{100} fed with 100% daily meal in which there's a positive allometric growth present (b = 3.357). Condition factor (CF) of brown trout fed with a full meal is slightly higher in group G_{100} and was 1.25±0.05 (min 1.18; max 1.29) on average, compared to group G_{80} in which individuals were fed with 80% of daily meal and was 1.23±0.04 (min 1.18; max 1.26) on average.

References

Arslan, M., Yıldırım, A. & Bektaş, S. (2004). Length-Weight Relationship of Brown Trout, *Salmo trutta* L., Inhabiting Kan Stream, Çoruh Basin, North-Eastern Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 4, 45-48.

Fisher, W.L. & Burroughes, J.P. (2003). Stream fisheries management in the United States. A survey of State Agency Programs. *Fisheries*, 28 (2), 10-18.

Froese, R. (2006). Cube law, condition factor and weight–length relationships: history, meta-analysis and recommendations. *J. Appl. Ichthyol.*, 22, 241-253.

Lans, L., Greenberg, L. A., Karlsson, J., Calles, O., Schmitz, M. & Bergman, E. (2011). The effects of ration size on migration by hatchery-raised Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*). *Ecology of freshwater fish*, 20(4), 548-557.

Muddasir, J., Neelofar, J. & Imtiaz, A. (2018). Length Weight Relationship (LWR) and Condition Factor (K) of Brown Trout, *Salmo trutta fario. Journal of Ecophysiology and Occupational Health*, Vol. 18(3&4), 73-79.

Nishikanta, K. & Motilan, Y. (2015). Length-Weight Relationship and Condition Factor of an Endemic Ornamental Cat Fish, Gagata dolichonema He, 1996 Manipur. *Indian Journal of Applied Research*. 5(5), 703-704.

Rawat, M.S., Bantwan, B., Singh, D. & Gusain, O.P. (2014). Length-weight relationship and condition factor of brown trout (*Salmo trutta fario* L.) from River Asiganga, Uttarakhand (India). *Environment Conservation Journal*, 15(3), 41-46.

Rechulicz, J. (2010). Size structure and body condition of brown trout (*Salmo trutta trutta* m. *fario* L.) from mountain-type river in Lublin Upland. Teka Kom. Ochr. Kszt. Środ. Przyr. – *OL PAN*, 7, 335-344.

Sangun, L., Akamca, E. & Akar, M. (2007). Weight-Length Relationships for 39 Fish Species from the North-Eastern Mediterranean Coast of Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, 7, 37-40.

Tanir, Z.Ö. & Fakioğlu, Ö. (2017). Density, Biomass and Length-Weight Relationship of Brown Trout (*Salmo trutta* Linnaeus, 1758) Population in the Çoruh River Basin, North-Eastern Anatolia, Turkey. *LIMNOFISH - Journal of Limnology and Freshwater Fisheries Research*, 3(3), 129-136.

Trožić–Borovac, S. (2002). Prehrana potočne pastrve, *Salmo trutta* m. *fario* L., u rijeci Uni. *Ribarstvo*, 60, 2002, (3), 83-104.

Original scientific paper

The average relatedness coefficient in Lipizzan horse from state-owned stud Vučijak

Sara Popadić[1], Biljana Rogić[1], Božo Važić[1]

[1]*University of Banja Luka, Faculty of Agriculture, Republic of Srpska*

Corresponding author: Biljana Rogić, biljana.rogic@agro.unibl.org

Abstract

The state-owned stud Vučijak was founded in 1946s in Prnjavor municipality, and today stud has 6 stallions' line and 15 mare families. Pedigree analysis is an important tool for identifying genetic diversity and changes that occur from generation to generation. Also, the pedigree allows the assessment of population structure and inbreeding levels, which are important for closed populations under high selection pressure. The aim of this work was to determine the average relatedness coefficient (AR) in Lipizzan horse from stud Vučijak using pedigree analysis. In this study, pedigree information from total of 121 Lipizzan horse was used, and animall was born between 1997 to 2017. For all animal was calculated the average relatedness coefficient (AR) in five generations. The AR was 0,048 (4,8%), respectively for mares 0,052 and stallions 0,041. For the purpose of monitoring the AR by years the animals are divided into two decades. The first group was animals born between 1997 and 2007 and the second group between 2007-2017. Results of t-test showed that there no significant differences for AR between mares and stallions, and between animals born in different decade. The ANOVA showed that there were differences for AR between stallion line, respectively mare families. Based on the obtained results, it could be concluded that the sire line Favory (0,23) and the mare families Ilova (0,014) have the smallest, and the sire line Conversano (0,065) and Maestoso (0,067), and the mare families Visla (0,074) and Sava (0,080) have the highest average relatedness.

Key words: Lipizzan, stud Vučijak, pedigree, the average relatedness coefficient

Introduction

The Lipizzan horse breed originate from an Austrian royal stud in Lipica (Slovenia), founded in 1580. The Lipizzan horse was formed by combining cross-breeding of the "karst" horse with Spanish, Italian, German, Danish, Kladrubski and most of Arabian horses (Pejić, 2015). From the Andalusian horse he inherited calmness and obedience, loyalty from the Arabian, grace from the Italian, and the firmness and resilience from the Karst horse (Sarajlić, 2015). This horse is known for its noble and solid body structure, resistance, modesty in accommodation and nutrition, easy learning and willingness to work, and the ability to fulfil even the most difficult tasks. The Lipizzan horse is a breed of the future, because it survives and adapts to all countries of its breeding, as well as to all parts of Bosnia and Herzegovina.

State-owned stud Vučijak is the only Lipizzan stud in Bosnia and Herzegovina. It was founded in 1946. Horse founders were obtained from different stud and breeders from the territory of the Republic of Croatia. Previous studies regarding the Lipizzan horse breed has been done on the farms Beclean and Fagaras (Romania), Đakovo (Croatia), Lipica (Slovenia), Piber (Austria), Monterotondo (Italy), Szilvasvarada (Hungary) and Topolcianky (Slovakia). Lipizzan horse breed from this stud has been scientifically described so far using various methods like: phenotypic characterization, morphometric measures, analysis of diversity and population structure using pedigree information, but also and modern genetic characterization using molecular methods (Zechner et al., 2001; Solkner et al., 2001; Druml et al., 2018). According Lipizzan horse from stud Vučijak, so far, there is results of the morphometry of stallions and mares (Rogić et al., 2018; Važić et al., 2016). The pedigree analysis is one way of exploring the genetic structure and diversity of the population. Additionally, pedigree analysis can enable us to estimate the population structure and levels of inbreeding that are important for populations with high selective pressure and closed registry books for many years (Gutiérrez et al., 2005). Therefore, the aim of this work was to determine the coefficient of relatedness in the Lipizzan stud Vučijak based on the pedigree in order to get a better insight into the quality of the selection work. Also, the obtained results were compared with the existing results of the research on other European studs, for the comparison and classification of Lipizzaner breed from the stud Vučijak in the total European horse population.

Material and Methods

The material used in this paper was the pedigree from Stud book of the stud Vučijak. As an additional source of data was "Stud Book of Lipizzan horse from stud Vučijak 1946-2007" (Stojanović et al., 2006). Vučijak currently has 6 stallions line (Neapolitano, Favory, Conversano, Siglavy, Pluto, Maestoso) and 15 mare families (Kremica, Janja, Neretva, Sitnica, Sutjeska, Lipa, Sava, Sana, Ukrina, Bregava, Jala, Drina, Ilova, Pliva i Visla). Pedigree data were collected for the period of 1997 to 2017. Every animal for which there were complete pedigrees back 5 generations was used in the work. At the end, the pedigree file contained 121 horse, 44 stallions and 77 mares. For every animal the average relatedness coefficient (AR) was calculated according to the Wright (1931). The AR measures the proportion of the genes, which is the same for two individuals and is inherited from a common ancestor. All animals are divided into two groups by gender. Within these groups, in order to estimate at the trend of AR over time, the mares and stallions are divided into two groups. The first group was animals born from 1997 to 2007 (I decade), and the second group from 2007 to 2017 (II decade). Also, in order to estimate differences of AR between sire lines, respectively mare families, animals are divided into 6 groups of lines, or 15 mares.

Determining of differences in the AR, between mares and stallions, respectively between animals born in I and II decade was done by a t-test. A simple analysis of variance was used to determine the difference in the AR between sire lines and mare families, whereby the F-test was calculated. The significance of the difference was tested based on the Duncan test at the significance level of 0.05. Animals for which AR were 0 (the animals that were not related) were not taken into statistical data processing. The statistical program SPSS17 was used for data processing.

Results and Discussion

So far, the Lipizzan horse breed from stud Vučijak was the subject of morphometric research of sire line and mare families, but the genetic parameters were not been investigated in recent years. In this paper, based on the pedigree, the AR of the Lipizzan horse from stud Vučijak was determined in order to better understand the breeding and the quality of the selection work. The study included a total of 121 animals, respectively 77 mares and 44 stallions. The AR at 37 stallions was higher than zero (AR> 0), and in the case of 7 stallions the coefficient was zero

(AR= 0). The AR at 69 mares was higher than zero (AR> 0), and in the case of 8 mares the AR was zero (AR = 0). The AR for all animals was 4.8%.

In order to understand the differences between the AR per gender, the results obtained are divided into two groups (mares and stallions), among which the tested significance of the difference. The results of the performed statistical data are shown in the following tables.

Table 1. Basic statistical parameters and t-value for AR for mares and stallions

Gender	*AV*	*SD*	*CV*	*Min*	*Max*	*t-value*
Mares	0.052	0.029	55.99	0.004	0.14	$1{,}80^{ns}$
Stallions	0.041	0.031	76.21	0.004	0.15	

The AR in mares was 0.052 (5.2%), and in stallions 0.041 (4.1%). The minimal value was 0.004 for both mares and stallions, and a maximum value was 0.14 for mares, respectively 0.15 for stallions. The results of the t-test showed that there is no statistically significant difference between the mean of the coefficient of relatedness both in mares and stallions (table 1).

For the purpose of monitoring the AR by years the animals are divided into two decades. The I decade was animals born between 1997 and 2007 and the II decade between 2007-2017. The obtained results for mares was showed in table 2.

Table 2. Basic statistical parameters and t-value for AR for mares born in the I and II decade

Decade	*AV*	*SD*	*CV*	*Min*	*Max*	*t-value*
I	0.050	0.032	64.2	0.008	0.14	0.64^{ns}
II	0.054	0.027	49.82	0.004	0.11	

The AR for mares born in I decade was 0.05, and for mares born in the II decade was higher 0.054. This result indicated that AR increases with year. To determine the significance of this increase, there was tested significance of the difference of average value using t-test. The results of t-test showed that there is no difference between the average values of AR between mares born in different decades (table 2).

The same testing also was carried for stallions. The AR in stallions born in I decade was 0.038, and also was higher for stallions born in II decade (0.044). As in the previous case (mares), the t - test also showed that there is no statistically significant difference for AR between the stallions born in I and II decades (table 3).

Table 3. Basic statistical parameters and t-value for AR for stallions born in the I and II decade

Decade	*AV*	*SD*	*CV*	*Min*	*Max*	*t-value*
I	0.038	0.028	73.76	0.004	0.10	0.66^{ns}
II	0.044	0.035	78.25	0.004	0.15	

The AR between sire lines in the Lipizzan horse breed from stud Vučijak

In order to understand the differences between the AR and the inbreeding level, the analyzed stallions are divided into 6 groups of sire lines. The results of the statistical analysis are presented in the table 4.

Table 4. Analysis of the variance for AR for the six sire lines

Sire Lines	*AV*	*F calculated*	*F tab*	
			0.05	0.01
Pluto	0.033	2.69*	2.53	3.70
Siglavy	0.033			
Maestoso	0.067			
Neapolitano	0.034			
Favory	0.023			
Conversano	0.065			

The calculated F-test (2.69) indicates that there is a statistically significant difference between the average values of the AR of the six sire lines from the stud Vučijak. The lowest AR was found in the Favory, and the highest in the Conversano and Maestoso sire lines.

Table 5. Duncan test of differences for AR between the six sire lines

	Pluto	*Siglavy*	*Maestoso*	*Neapolitano*	*Favory*	*Conversano*
Pluto	-	ns	*	ns	*	*
Siglavy	-	-	*	ns	*	*
Maestoso	-	-	-	*	*	ns
Neapolitano	-	-	-	-	*	*
Favory	-	-	-	-	-	*

The mean value of the AR of the Favory sire line was statistically different from the other sire lines. The Conversano sire line had the AR which statistically different in relation to the mean value of all sire lines, except the Maestoso. The sire line Neapolitano had the AR statistically significant in relation to the Favory, Conversano and Maestoso sire lines.

The Favory sire line is the least influenced by inbreeding in relation to the other sire lines of the stud Vučijak, and on the other hand, sire lines of Conversano and Maestoso are the most influenced by the inbreeding.

The AR between mare families in the Lipizzan horse breed from stud Vučijak

In order to examine the genetic parameter of the relatedness of the mare families of the stud Vučijak, the analyzed mares was divided in 15 mare families. The AR was calculated, and in addition, the mean values were tested, and the results are presented in the following tables.

Table 6. Analysis of the variance for AR for the fifteen mare families

Mare families	*AV*	*F-calculated*	*F- tab*	
			0,05%	0,01%
Neretva	0,054	2,14*	1,95	2,56
Pliva	0,026			
Sana	0,043			
Ilova	0,014			
Sitnica	0,038			
Visla	0,074			
Bregava	0,060			
Janja	0,043			
Ukrina	0,047			
Jala	0,054			
Sava	0,080			
Lipa	0,067			
Sutjeska	0,048			
Kremica	0,030			
Drina	0,034			

The F-test sowed that there was a statistically significant difference for AR between the mare families of the stud Vučijak. The lowest AR was in the Ilova, and the highest in the Visla and Sava mare families.

Table 7. Duncan test of differences for AR between the fifteen mare families sire

	Neretv	*Pliva*	*Sana*	*Ilova*	*Sitnica*	*Visla*	*Bregava*	*Janja*	*Ukrina*	*Jala*	*Sava*	*Lipa*	*Sutjeska*	*Kremica*	*Drina*
Neretva	-	*	ns	*	*	*	*	ns	ns	ns	*	*	ns	*	*
Pliva	-	-	*	*	*	*	*	*	*	*	*	*	*	ns	*
Sana	-	-	-	*	*	*	*	ns	ns	ns	*	*	ns	*	*
Ilova	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*
Sitnica	-	-	-	-	-	*	*	*	*	*	*	*	*	*	ns
Visla	-	-	-	-	-	-	*	*	*	*	*	*	*	*	*
Bregava	-	-	-	-	-	-	-	*	*	*	*	ns	*	*	*
Janja	-	-	-	-	-	-	-	-	ns	ns	*	*	ns	*	*
Ukrina	-	-	-	-	-	-	-	-	-	ns	*	*	ns	*	*
Jala	-	-	-	-	-	-	-	-	-	-	*	*	ns	*	*
Sava	-	-	-	-	-	-	-	-	-	-	-	*	*	*	*
Lipa	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*
Sutjeska	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*
Kremica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*

The mean values of the AR of the Visla, Sava and Ilova statistically significantly differed from other mare families. According results of Duncan test it could be concluded that mare families Ilova is the least influenced by inbreeding, and on the other hand, mare families Visla and Sava are the most influenced by the inbreeding.

By insight into the literature, it could be concluded that the Lipizzaner horse on the stud of "Vučijak" is less burdened by the coefficient of relatedness compared to the Arabian horse from Turkey, whose coefficient of relatedness was 9.5% (Duru, 2017).

On the other hand, the average value of the coefficient of similarity in the Czech Hucul horse was 0.13% in the reference population (Vydrová et al., 2015), which indicates less burden of breeding in relation to Lipizzaner horse.

Conclusion

In conclusion, this work was the first pedigree analysis of AR of the Lipizzan horse breed from stud Vučijak. Obtained results showed that mare families Ilova and sire lines Favory are the least influenced by inbreeding. Also, mare families Visla and Sava, respectively sire lines Conversano and Maestoso are the most influenced by the inbreeding. These results have a practical meaning and should be useful when preparing the next animal mating plan in the stud Vučijak.

Referencess

Duru, S. (2017). Pedigree analysis of the Turkish Arab horse population: structure, inbreeding and genetic variability. *Animal*, 11:9, 1449–1456.

Pavlík, I., Schubertová, Z., Kadlečík, O., Candrák, J. & Kasarda, R. (2014). Pedigree analysis of Thoroughbred horses in Slovakia. *Acta fytotechn. zootechn.*, 17, 122–126.

Pejić, S. (2015). *Uzgoj konja Lipicanske pasmine u Republici Hrvatskoj*. Završni rad. Sveučilište Josipa Jurja Strossmayera. Poljoprivredni fakultet u Osijeku.

Rogić, B., Važić, B. & Sarajlić, Đ. (2018). Breeding goals and selection effort in the breeding of Lipizzan horses in the stud farm Vučijaka from 1946 to 2015. *Genetika*, Vol 50, No. 1, 253-259.

Sarajlić, Đ. (2015). *Morfometrija Lipicanca ergele „Vučijak"*. Magistarski rad. Univerzitet u Banjoj Luci. Poljoprivredni fakultet.

Stojanović, M., Kasagić, D., Matarugić, D. & Važić, B. (2006). *Ergela Vučijak 1946-2006 - matična knjiga lipicanca*, Banja Luka.

Važić, B., Sarajlić, Đ. & Rogić, B. (2016). Morphometric characterization of the Lipizzaner horse breed in the stud „Vučijak". *Biotechnology in AnImal Husbandry*. Beograd, Vol. 32(2), 219-227.

Vydrová, V.H., Vostrý, L., Hofmanová, B., Veselá, Z., Schmidová, J. & Majzlík, I. (2015). Population studies of Czech Hucul horses. *Poljoprivreda*, 21 Supplement, 41-43.

Koeficijent rodbinstva lipicanca ergele Vučijak

Sara Popadić[1], Biljana Rogić[1], Božo Važić[1]

[1] *Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka, Republika Srpska*

Autor za korespondenciju:Biljana Rogić, biljana.rogic@agro.unibl.org

Sažetak

Ergela „Vučijak“ je jedina lipicanska ergela u Bosni i Hercegovini koja je osnovana 1946. godine. Danas ergela ima 6 linija i 15 rodova. Analiza pedigrea je važan alat za identifikaciju genetičke raznolikosti i promjena koje se javljaju iz generacije u generaciju. Takođe, pedigre omogućava procjenu strukture populacije i nivoe inbridinga, koji su važni za zatvorene populacije pod visokim selekcionim pritiskom. Cilj ovog rada bio je da se na osnovu pedigrea utvrdi koeficijent rodbinstva lipicanca ergele „Vučijak“ radi boljeg uvida u kvalitet selekcijskog rada. U radu su korišteni matični listovi sa ergele „Vučijak“, kao i „Matična knjiga lipicanca ergele Vučijak 1946-2007“. Svaka životinja za koju se imao potpun pedigre unazad 5 generacija je dalje korištena u radu. Ukupno je analiziran pedigre za 121 životinju i za svaku od njih je izračunat koeficijent rodbinstva. Prosječna vrijednost koeficijenta rodbinstva (Rxy) je iznosila 0,048 (4,8%). Koeficijent rodbinstva kod kobila je bio 0,052 a kod pastuva 0,041. Koeficijent rodbinstva kod kobila oždrebljenih u periodu od 1997-2007 je iznosio 0,050 a kod kobila oždrebljenih u periodu od 2007-2017 je iznosio 0,054, odnosno kod pastuva u prvom periodu je bio 0,038 a u drugom 0,044. T-test je pokazao da razlike između kobila i pastuva, odnosno između kobila i pastuva oždrebljenih u različitim periodima nisu statistički značajne. Testiranje razlika između pojedinih predstavnika linija, odnosno rodova, rađena prostom analizom varijanse i računanjem F, odnosno Duncan testa. Analiza varijanse je pokazala da postoji statistički značajna razlika u koeficijentu rodbinstva između pojedinih linija Na osnovu dobijenih rezultata može se zaključiti da su linija Favory (0,23), odnosno rod Ilova (0,014), najmanje opterećeni uzgojem u srodstvu s jedne strane, a linije Conversano (0,065) i Maestoso (0,067), i rodovi Visla (0,074) i Sava (0,080), najviše opterećene uzgojem u srodstvu.

Ključne riječi: lipicanac, ergela Vučijak, pedigre, koeficijent rodbinstva

Original scientific paper

Technological process of milking and quality of milk on a commercial farm

Biljana Veljković[1], Ranko Koprivica [1], Dušan Radivojević [2], Zoran Mileusnić[2], Aleksandar Kuč[3]

[1] Faculty of Agronomy, University of Kragujevac, Cara Dušana 34 Čačak, Serbia
[2] Faculty of Agriculture, University of Belgrade, Nemanjina 6 Zemun Beograd, Serbia
[3] Cow farm Kuč Company, Carice Milice bb. Lapovo, Serbia

Corresponding author: Biljana Veljković, biljavz@kg.ac.rs

Abstract

Quality and hygienic correctness of milk depends to a large extent from milking procedures at the farm. There are numerous rules and recommendations on the subject of properly milking cows depending of the milking equipment used at the farm. However, over time workers (dairyman) get practical experience and this procedure becomes a routine. The main goal of this article was to show practical experience and time organization of milking operations on the commercial farm. The milking was performed in milking place fishbone (2x8). Average daily milk yield per cows was from 10.87-13.85 L depending on which milking group they belong to. The chronometric recording of the process of milking and individual procedures in the process of milking, and also duration of milking was analyzed. Time of milking has participated 71%, procedures before milking 21.25%, and procedures after milking 8.35% of the total time during the milking operation. Dairyman where milking from 32.39-38.14 cows per one hour. Rationalizing the time and energy of work in the milking process can increase the volume and quality of milk obtained per unit of capacity and working time. Chemical analysis of milk quality determined that on average it contains 4.48% fats, 3.82% proteins, and 9.32% dry matters. Produced milk on the farm was in extra class.

Key words: milking time, chronometric methods, quantity and quality of milk

Introduction

Good organization of milking on the farm could improve production results. In addition to the used equipment, training and experience of the dairyman, good manufacturing practice and recommendations should be adopted and applied which relate to the cow milking. In order to make cows' milking consistent and simple, recommendations were given by experts of Madison University in Wisconsin through the seven basic rules for milking cows: Cows should be grouped according to milkiness; Cows should be clean and not upset before milking; Routine in preparing cows for milking should be consistent and harmonized; Udder should be dry when putting milking sets; Properly install milking sets on the udder; Properly remove milking sets from udder; After the milking, udder disinfection should be performed (Plavšić, 2004). By applying adequate and permanent routine in the preparation of dairy cows the amount of milking could be increased milk for about 5.5%. Applying good manufacturing practice and proper milking keeps the health of the udder, cow and milk is hygienically safe. By monitoring the number of somatic cells and the milk flow curve it can be observed that the cow udder becomes more resistant to diseases (Mijić et al., 2003). In the case of semi-stationed milking systems, participation of human labor and machinery is bigger per dairy cow, therefore at the larger farms the milking place has the advantage (Škaljić et al., 2017). On commercial and larger family farms in Serbia, from stationary milking place the "fishbone" is mostly used, because they are suitable for a free holding cow system, with (2x4) up to (2x8) places for milking by cows.

The organization of labor in the milking process is conceived in a way that it has an important share in the structure of the basic working time. During the working time, the worker is about 70% time employed in the milking process and 30% for maintenance and cleaning the stables, care and feeding of cows (Nemeš et al., 2006). The process of milking the cow lasts from 3 to 8 minutes with a significantly shorter mechanical time (4.42 min) than hand milking (6.05 min). More milk was milked mechanically (5.06 L) than in the manual milking (3.69 L). The number of microorganisms and somatic cells is considerably lower in machine milking and the average milk yield per cows is higher than in a milking by hand. The goals of this research were, using chronometry, to analyze the duration of the individual procedures in the milking process and determine the productivity in the "fishbone" place.

Material and Methods

Research has been carried out on the commercial farm Kuč in Lapovo. In the period of the observation on the farm, the farm had 175 dairy cows of Simmental breed in the free farming mode. For milking process used to milking place type "fishbone" producers Alfa Laval, which can milk up to 16 cows (2x8) at once. Milking cows was done twice a day, in the morning and evening (6 am and 6 pm). The methods of chronographic analysis and chronometric measurement were used to determine time of duration of the milking process. Each dairy cow had identification code which is systematically connected to a computer and enable monitoring of time of milking and milk yield. The process of milking was divided into work operations which include: procedures before milking, procedures during the milking, and procedures after milking. Following time duration were measured: cows entering in the place of milking, disinfecting and wiping the udder, putting up milking units, the milking process, and disinfection or closing the canal of teats, and cows exit from the place of milking. According to the milk yield cows were divided into three groups on the basis of which their diet was adapted. In the second and third group cows are classified immediately after calving and most cows belonged to these groups. Analyzes of raw milk were performed in authorized laboratories for dairy "Kuč Company" in Kragujevac.

On commercial farm „Kuč“, milking is done in the morning and evening. The process of milking begins when cows enter from the waiting room on both sides in the milking position. By entering 8 cows on both sides of the ramp, the milking places are closed. The cows stand in the milking place (fishbone) arrange at angle 35^0 to the working channel. The heads are turned toward feeders, and udders are faced to the work channel and dairyman at hands. The channel is located in the middle of the milking place with a depth of 90 cm in there are two dairy workers. Milk is accumulated in graduated mensura, from which the milk pipe goes to the milk cooling tank. Preparation of the milking process starts with the disinfection of the udder to prevent penetration microorganisms and bacteria. After disinfection is done massage the udder with paper towel. Putting up the milking cups on the tits starts the milking. After the milking is done worker removes milking units do disinfect and closes canal of teats and protects the udder, so that the udder doesn`t get contaminated by microorganisms. The last milking, cows leave the milking place by opening the exit ramp and milking process is finish. The fish bone construction requires the worker to work with several milking units (8 or 16), rational

organization of work is needed to maximizes the outcome of this process and two workers are recommended for this job.

Results and Discussion

The chronograph recording of the duration of the milking process for one dairyman in the milking place fishbone for a group of 8 cows is given in Table 1. The average time spent for milking process, for the total duration time, was 755 s for I group and up to 890 s for III group of cows. In all three groups of cows, the time of entry of cows into the milking place was balanced to 41-47 seconds, wiping the udder 37-49 s, as well as disinfection of the tits before 27-30 and after 25-31 s. Differences of the time duration are in the operation of setting milking units 42-73s, as well when the cows are leaving the milking place 35-61 s (Tab.1).

Table1 Work time spent in milking process in the milking place in s (for 8 cows)

The milking process by work operation in seconds	Group of cows		
	I	II	III
Entering cows into milking place	42	41	47
Disinfection of tits before milking	30	28	27
Wiping the udder	37	49	48
Placing milking units	42	63	73
Milking	544	562	640
Disinfection of tits after milking	25	31	21
Exit cows from milking place	35	61	34
Total milking time	755	835	890

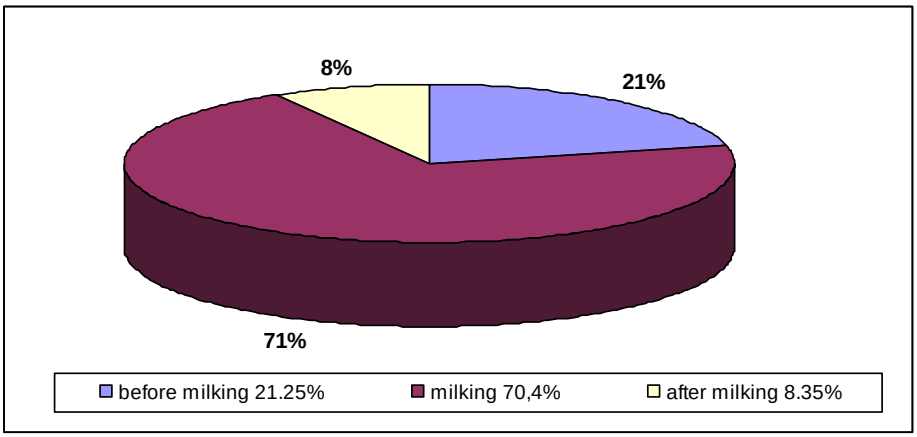


Figure 1. Percentage participation of work operations in milking process in the milking place

In the process of milking, the most time was spent on machine labor (milking devices) from 544 to 640 s per cow (Tab. 1). The work of the dairyman in these procedures before and after the milking for a group of eight cows was 211 to 273 s, which average was, 29.60% of the total time of the milking. The participation percentage in average time of effective cows milking are 70.4%, procedures before milking are 21.25% and after milking 8.35% of the total time during the milking (Fig. 1). Washing the milking place was not taken in the total time of the milking, and it was approximately 40 minutes after milking.

The amount of milk in one group of 8 cows was 86.98 -110.81 L. Productivity of one dairyman for 1 hour of milking in the place of milking fishbone was 32.39 - 38.14 cows. For the same time, for 1 hour, milking gave 414.74 - 448.22 L of milk. Productivity achieved for the milking of one cow is 94.37 -111, 25 seconds (Tab. 2).

Table 2. Work performance of milking in the milking place fishbone (for 8 cows)

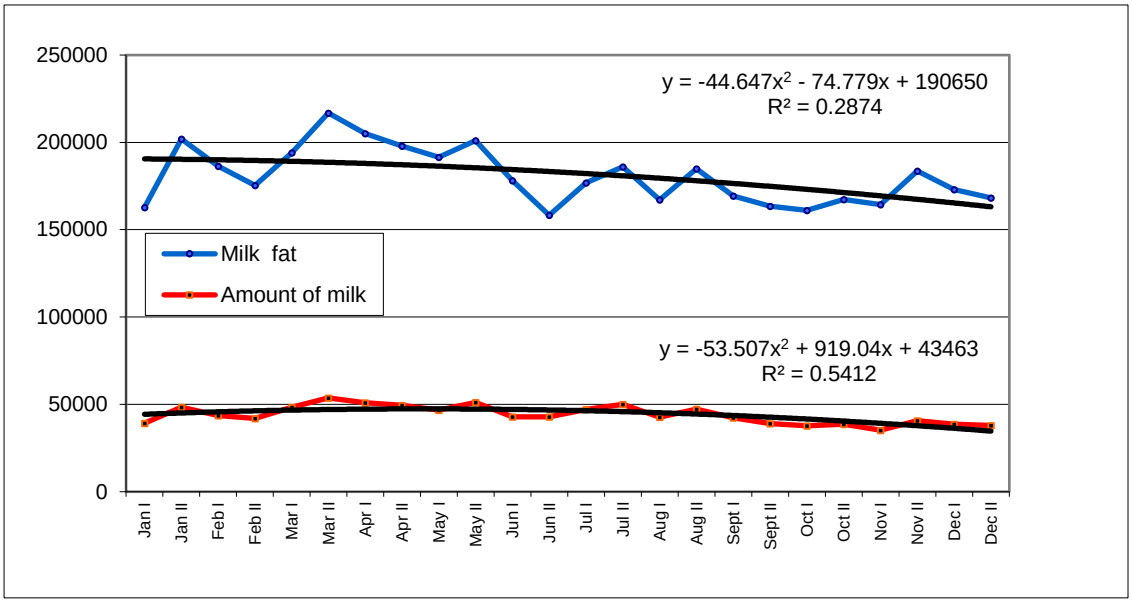
Realized performance during cows milking	Group of cow		
	I	II	III
Amount of milk in L	86, 98	103,23	110,81
Amount of milk per cow in L	10,87	12,90	13,85
Number of milking cow per hour	38,14	34,49	32,39
Amount of milking milk per hour in L	414,74	445,06	448,22
Productivity of milking per cow in s	94,37	104,37	111,25
Time of machine work in s	544	562	640
Time of dairyman in s	221	273	250
Needed time for a liter of milk per second	8,60	8,09	8,03

The productivity of milking may be affected by: milkness of cow, udder softness, procedures in milking process and the organization of the process, knowledge and experience of workers, as well the milking devices correctness (height of the vacuum, vacuum variation, wear of the tits rubber, etc.). Comparing obtained results with similar research performed by Vučetić et al. (1988) in the milking place fishbone (2x8), the average productivity of the milking was 92.84 -106 seconds for the milking one cow at the farm.

The permeate power of the milking place was 70.78 - 84.70 cows /hour in the work of two dairymen, and in this research it was 32,39 - 38,14 cows/hour for the work of one dairyman. According to Lučić et al. (2002) in the milking place (2x6) for one hour of work milking 48,12 cows and get 371,39 L milk. The biggest participation had the time of milking 3.77 minutes per cow, i.e. 35.77%, followed by till milking 32.63%, and the cows entry/exit in the milking

place participates 32.36% of the total working time. In this organization of work, the permeate power of the milking place was 48.12 cows /hour.

In the observed years at the farm, the quantities of milk ranged from a minimum 35214 L in November to a maximum 53711 L in March, when the values of milk fat reached 216,858 kg (Graph 1).



Graph 1. The amount of milk and milk fat in the farm Kuč Lapovo

According to the analyzes on the quality of milk produced by "Kuč Company", the milk produced on the farm average had: 4.48% milk fat, 3.82% protein, 9.32% dry matter, and pH 6.7. Microbiological analyzes shown that the number of microorganisms were between 10000-30000, and somatic cells from 22000-93000.

According to the regulations of Serbia and the European Union, milk was classified in extra class. The number of somatic cells in milk is one of the important factors in the assessment of milk quality, it is a good indicator for the prevention and monitoring of mastitis in cows, and it is used to classify milk and form the purchasing price (Veljković et al., 2013; Koprivica et al., 2013).

If preparations of before and after the milking process are properly performed, with clean milking devices, the milk will be of excellent quality, no matter what system for milking is used (Radivojević et al., 2011).

Conclusion

The milking process at dairy farm is done daily in the morning and in the evening. Proper milking process and dairyman practice contributes to a great extent to achieve good productivity and efficiency in these operations. Rationalizing the time and energy of work in the milking process can increase the volume and quality of milk obtained per unit of capacity and working time. Methods of preparing the milking process and application of hygienic measures before and after milking contribute to unhindered mechanical milking considering that the most milk milked is within the first 4 minutes. Good organization and proper procedures during the milking contribute to get milk within the extra class, which improves the conditions of milk purchase, guarantees a better purchase price and the viability of the production.

Acknowledgments

The research presented in this paper is part of Project Ref. No. TR. 31051 financially supported by the Ministry of Education, Science and Technological Development, Republic of Serbia.

References

Filipovic, D. & Kokaj ,M. (2009). The comparison of hand and machine milking on small family dairy farms in central Croatia. *Livestock Research for Rural Development*, 21 (5).

Koprivica, R., Veljkovic Biljana, Radivojević, D., Petrović, M., Barać, S. & Marić, Marina (2013). Milk quality on family farms depending on the proper function of milking system. J*ournal of Mountain Agriculture on the Balkans,* vol. 16, 4, 847-862.

Lučić, Đ., Krstić, B. & Balasa, M. (2002). Organizacija savremene govedarske farme na porodičnom gazdinstvu. *Agroekonomika*, br. 31, 93-98, Poljoprivredni fakultet, Novi Sad.

Mijić, P., Knežević, I., Caput, P. & Baban, Mirjana (2001). Protok mlijeka pri strojnoj mužnji holštajn-frizijskih I simentalskih krava u Hrvatskoj. *Stočarstvo,* 55 (3), 163-179.

Nemeš, Ž., Lučić, Đ., Marković, M. & Miailović, V. (2006). Produktivnost rada muzača u klasičnim štalama. *Savremena poljoprivreda,* LV 1-2, 28-34.

Plavšić, M. (2004). Sedam pravila koja garantuju uspešnu mužu i efikasnu proizvodnju kravljeg mleka. *Savremeni farmer*, br. 17–20, Poljoprivredni fakultet, Institut za stočarstvo, Novi Sad.

Radivojević, D., Ivanović, S., Veljković, B., Koprivica, R., Radojčić, S. & Božić, S. (2011). Uticaj različitih muznih sistema na kvalitet mleka u toku muže krava. *Poljoprivredna tehnika*, vol. 36, br. 4, 1-9.

Škaljić, S., Rakita, N. & Pekmez, M. (2017). Produktivnost rada polustacioniranih sistema mašinske muže. *Radovi Poljoprivredno-prehrambenog fakulteta Univerziteta u Sarajevu*, God. LXII, broj 67/2, 367-375.

Veljković, B., Koprivica, R., Radivojević, D. & Ivanović, S. (2013). *Analiza kvaliteta i otkupnih cena mleka na porodičnim farmama*. XVIII Savetovanje o biotehnologiji, Agronomski fakultet, Čačak, Zbornik radova, vol. 18, br. 20, 391-397.

Vučetić, S., Čobić, T., Bačvanski, S. & Plavšić, M (1988). *Ispitivanja proizvodnih i iskoristivih sposobnosti dva izmuzišta za krave tipa "riblja kost"*. Zbornik radova, br. 17-18, Institut za stočarstvo, Novi Sad.

Tehnološki postupak muže i kvalitet mleka na komercijalnoj farmi

Biljana Veljković[1], Ranko Koprivica[1], Dušan Radivojević[2], Zoran Mileusnić[2], Aleksandar Kuč[3]

[1] *Agronomski fakultet, Unvierzitet u Kragujevcu, Cara Dušana 34 Čačak, Serbia*

[2] *Poljoprivredni fakultet, Univerzitet u Baogradu, Nemanjina 6 Zemun Beograd, Serbia*

[3] *Farma krava Kuč, Carice Milice bb. Lapovo, Serbia*

Autor za korespondenciju: Biljana Veljković, biljavz@kg.ac.rs

Sažetak

Od postupaka izvođenja muže na farmi u velikoj meri zavisi kvalitet i higijenska ispravnost mleka. Brojna su pravila i preporuke kako treba izvoditi mužu na farmi muznih krava u zavisnosti od opreme za mužu koja se koristi. Međutim vremenom radnici (muzači) stiču praktično iskustvo i ovaj postupak postaje rutina. Cilj rada je prikazati ova praktična iskustva i organizaciju izvođenja muže na komercijalnoj farmi. Muža se obavljala u izmuzištu riblja kost (2x8). Prosečna mlečnost krava po grlu kretala se od 10,87-13,85 L u zavisnosti od toga kojoj muznoj grupi pripadaju. Hronometrijskim snimanjem pojedinačnih postupaka u procesu muže analizirano je vreme trajanja muže i rad muzača po redosledu radnih operacija. Vreme muže je učestvovalo sa 71%, postupci pre muže sa 21,25%, a postupci posle muže sa 8,35% od ukupnog vremena. Tokom rada muzač za sat vremena pomuze od 32,39-38,14 krava. Racionalizacijom vremena i energije rada pri muži može da se poveća obim i kvalitet dobijenog mleka po jedinici kapaciteta i vremenu rada. Hemijskom analizom kvaliteta mleka utvrđeno je da u proseku sadrži 4,48% masti, 3,82% proteina, i 9,32% suve materije. Proizvedeno mleko na farmi je bilo u extra klasi.

Ključne reči: vreme muže, hronometrija, količina, kvalitet mleka

Original scientific paper

The relationship between import of feed for salmonids and export of trout from BiH

Aleksandar Ostojić[1], Nebojša Savić[1], Jerko Pavličević[2], Željko Vaško[1]

[1]*Faculty of Agriculture, University of Banja Luka, Bulevar vojvode Petra Bojovića 1A, Banja Luka, Bosnia and Herzegovina*

[2]*Faculty of Agriculture and Food Technology, University of Mostar, Biskupa Čule bb, Bosnia and Herzegovina*

Corresponding author: Aleksandar Ostojić: aleksandar.ostojic@agro.unibl.org

Abstract

Freshwater fishery in Bosnia and Herzegovina is one of the most developed sectors in the agro-industry. The subject of the study is an analysis of the market trends and foreign trade of Bosnia and Herzegovina, import feed for salmonid species of fish and export trout. The aim of this paper is to determine the dependence on the imports of fish feed and the coverage of its imports by exporting trout. This paper analyses these two factors over a ten-year period (2010-2018). The source of the analysed data is secondary sources and the research was conducted using the so-called method desk research. Data processing was done through mathematical-statistical methods. The results of the research have shown that in the structure of imported fish feed dominates feed for the feeding of salmonid fish species (around 83%). At the same time, the export of fish is dominated by rainbow trout. The export value of trout in the analysed period was greater than the value of the imported feed for salmonids. The export price of trout grew at a higher average annual rate (2.72%) than the price of imported fish feed (1.38%), which means that the value added to the value of imported feed increased in favour of the final product. The conclusion is that Bosnia and Herzegovina mainly imports fish feed from the countries of the European Union and that it is not realistic to substitute feed imports for salmonids because of the lack of components of domestic origin for its production. However, the import of salmonid feed is justified because it is completely covered by the export of trout fattened with that feed. Bosnia and Herzegovina is predominantly exporting trout while its

imports of smaller scale, whereby permanently achieving surplus in this product in international trade and it contributes significantly to the reduction of the foreign trade deficit.

Key words: Trout, imports, exports, fish feed, added value.

Introduction

Bosnia and Herzegovina has significant potentials for fish production from the point of view of water resources and the development of the processing industry in this sector. However, besides production of salmonids, primarily trout, according to the statistical indicators in BiH oscillates year after year. Fish is considered to be a very healthy product due to its chemical and nutritional composition and easily digestible. Of animal products, fish is the first product that has received approval for exported to the common European market.

Pavličević et al. (2014) presented the results of the research where the term "healthy feed", when it comes to fish, is justified by a number of studies in which the positive influence of intake of polyunsaturated fatty acids from fish meat on human health. However, besides that numerous studies have shown that fish as a product is not consumed in sufficient quantity. The most common reasons are price, lack of habit in consumption and others (Čaldarović et al., 2007; Franičević, 2012; Ostojić et al., 2017). According to the study Opačak et al. (2007) for meat as a meal in Croatia every day decides 41% of consumers and for fish 16%.

Pavličević et al. (2015) state that in the period (2010-2014) "fish, fresh and refrigerated" (0302) have a positive balance and on average the surplus was about BAM 1.5 million. In addition, the CT 0305 ("fish dried, salted or in brine, smoked fish") showed a positive trade balance, with a tendency of constant decline and if it continues at this pace it is likely that it will in the coming period have a negative balance. Generally speaking, according to the mentioned authors of BiH within the scope of Chapter 3 of the Customs Tariff, realizes a deficit.

Ostojić and Vaško (2019) indicate that trout at the foreign trade from all types of meat recorded a surplus as well as that the BiH domestic production of BiH did not satisfy the domestic consumption, with the exception of trout meat and exported between 34% and 62% of the total produced trout. The aim of this paper is to determine the dependence on imported fish feed and the coverage of its imports with the export of trout. The subject of the study is analysis of the market trends and foreign trade exchange of Bosnia and Herzegovina, import of feed for salmonid fish species and export of trout.

Material and Methods

The available data of the Indirect Taxation Authority and the Agency for Statistics of Bosnia and Herzegovina were used for research. In accordance with the Harmonized System of Customs Tariffs (CT 01-24) of Bosnia and Herzegovina, for the purpose of this paper some tariffs have been analysed under headings 3 and 23. The paper analyses the period from 2010 to 2018 with regard to import of fish feed with special references to feed for salmonids, as well as the export and import of trout as the dominantly cultivated salmonid species of fish in BiH. In addition, the production of trout was also analysed. For analysing the production of trout the period taken for observation was 2010-2017 due to the lack of dater that is not publishing the date on production for 2018 was not included. The research, given the data sources as well as the data type, was carried out by a direct data collection method so-called "desk research". Data processing in the paper was carried out using mathematical-statistical methods (descriptive statistics and rate of change). For the analysis of the coefficient of export-import conditionality i.e. the added value of the product, coefficients are calculated as the ratio of the value of trout export and feed imports.

$$K = \frac{E_y}{E_x}$$

Wherein the symbols have the following meaning:
K – coefficient of export-import conditionality;
Ey – value of export trout;
Ex – value of imported feed for salmonids.

Results and Discussion

The paper is divided into three parts, first analyses the production of trout in Bosnia and Herzegovina and importing fish feed with special emphasis on salmonids. The second part analyses the export and import of trout and trout products, and in the third part the analysis of the ratio of trout and trout products compared to the value of import of salmonid feed (coefficients of export-import conditionality).

Production of trout and import of fish feed in Bosnia and Herzegovina

On average, in the observed period, Bosnia and Herzegovina produced 2,955 tons of trout and it is evident that the production was quite stable (Cv = 9.89%). Maximum production was in 2016 and the lowest in 2013. With the exception of production in 2010 the production of trout from 2011-2012 recorded the trend of decline, while from 2013 to 2016 the production had an increasing trend. In 2017, production comes to a drop to around 358 tonnes.

Table 1. Production of trout in Bosnia and Hercegovina (2010-2017)

Fish	Average (ton)	Variation interval		CV (%)	Variation rate (%)
		min	Max		
Trout	2,955.84	2,381.80	3,394.90	9.89	0.66

Source: Own calculations based on the data of the Agency for Statistics of B&H.

In the analysed period, Bosnia and Hercegovina was import dependent in terms of fish feed (Table 2) and in average imported approximately 9.7 million BAM of fish feed, with the maximum value being 10.7 million (2011) and the smallest 7.8 million (2017). Analysing the total import of fish feed to Bosnia and Herzegovina it is noticeable that it is quite stable according to the coefficient of variation 10.53%. The most intense oscillations are notable in feed for carp (108.74%) and sub-groups of others (107.33%). In the period 2016-2018 there were no registered import of feed for carp so the processing of the date covers up to the period until 2016. It is evident that the decline of feed imports for carp is a direct consequence for the decline of this type of fish production as well as less intensive breeding compared to salmonids and the possibility of substitution of feed from the domestic market.

Table 2. Import of fish feed (2010-2018)

Feed	Average (000 KM)	Variation interval		CV (%)	Variation rate (%)
		min	max		
Salmonids (Trout)	8,142.10	6,602.16	9,423.54	12.13	1.16
Carp	587.59	53.63	1,540.53	108.74	-44.58
Sea fish	931.98	702.39	1,190.61	19.71	0.46
Aquarium fish and turtles	138.71	91.50	199.34	32.62	-3.09
Other	96.24	11.30	316.08	107.33	-14.01
Total	9,700.75	7,822.04	10,736.99	10.53	-0.45

Source: Own calculations based on the data of the Indirect Taxation Authority of B&H.

The dependence on imports of fish feeds is particularly emphasized in trout, i.e. salmonid, which accounts for 83% of the total value of imported feed in the observed period. The import

feed for salmonids, although variable, depending on the coefficient of variation is quite stable (12.13%). Feed for salmonids was in average around 8.1 million, with a maximum in 2013 and a minimum in 2017. The annual rate of change in feed for this species of fish was in average 1.16%. Analysing the dynamics import based on the original dater can be extracted sub-periods from 2010-2012 and from 2014-2017 when there was a decline in imports of salmonid feed. In the period 2010-2012 there is a decline of imports at an average annual rate of -6.18%, while in the second sub-period the decline was at a rate of -10.85%. The maximum import was achieved in 2013. In the last year, 2018, there is a growth in imports of salmonid feed (BAM 9 million). Salmonid feed is mainly imported from EU member states. Among them dominates feed from Italy. The share of Italy in the total import of feed for salmonids varies from 76 % up to 96%. Besides Italy feed was also imported from Denmark, France, Holland, Poland and Slovenia. Since 2014 it has been imported sporadically from Austria and Germany. From non-EU feed was imported from Serbia, especially from 2010 to 2012, and from Turkey.

Import and export of trout and trout products

Data on imports and exports of trout are summarized shown by the tariff numbers relating to salmonids. The data presented in Table 3 shows that Bosnia and Herzegovina is experiencing a surplus in the foreign trade of trout and its products. Bosnia and Herzegovina exported salmonids in the value from 8.8 million to 10.5 million BAM. Exports from BiH are quite stable (coefficient of variation 12.95%).

Table 3. Foreign trade of trout and trout products (2010-2018)

Fish	Average (000 KM)	Variation interval		CV (%)	Variation rate (%)
		min	max		
Export	8,812	7,651	10,657	12.95	0.45
Import	248	14	729	99.21	51.15
Surplus	8,564	7,202	10,643	15.02	-0.71

Source: Own calculations based on the data of the Indirect Taxation Authority of B&H.

Import shows intensive oscillation (99%) which indicates that it is a matter of unstable import of trout to BiH. Generally, import in the observed period was modest. When observing the movement and the tendency of the balance of foreign trade it is noticeable that during the nine years it was at all times positive. The total surplus has decreased over the analysed period at an average annual rate of -0.71%. The surplus had a positive trend in the sub-period from 2010 to

2012, the surplus grew at an average annual rate of 10.08%. From 2013 until 2014 there was decline of surplus at a rate of -7.98%, and the same is the case with the sub-period 2015-2018, when the decline was -12.21%. It is positive that in the export appears product of bigger added value such as fillet and smoked trout, alongside with live and fresh fish.

Ostojić and Vaško (2019) indicate that the export structure is more diverse than import, so that in the exported quantities appears also refrigerated, frozen trout filet and smoked trout. In compare to the quantitative structure of exports, in the value of exports participate more fillets of trout and smoked trout due to a higher export prices in compare to the fresh trout. Savić et al (2018) indicates that Bosnia and Herzegovina has mostly exported, both in quantities and value, trout that was fresh or in refrigerated state.

Analysis of the relationship between import of feed for salmonids and export of trout and trout products

Trends in fish production in developed markets are oriented towards products with higher added value in order to be differentiated compared to competing products, while in less developed markets the accent is still on live and refrigerated fish. Considering the ratio of the value of imports of feed for salmonids and export of trout and trout products reveals the impact of the value-added products that are exported from BiH (Chart 1). Value higher than 1 indicate that the value of export of finished products was higher than the value of imported feed. Chart 1 show's that there are oscillations in the movement of the coefficient of export-import conditions during the analysed period. The most favourable ratio was achieved in 2016 (1.44).

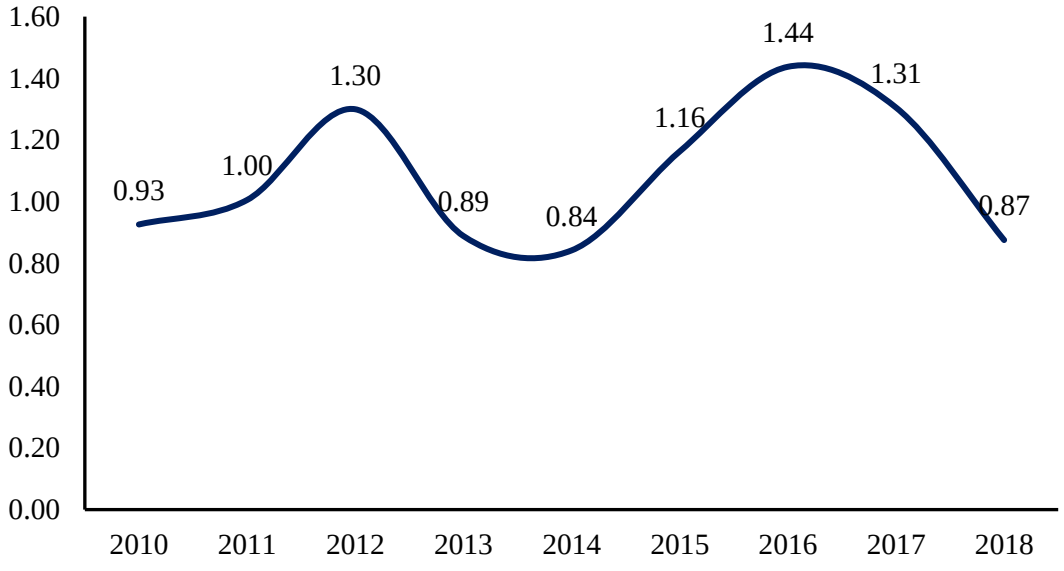


Chart 1. The movement of the coefficient of export-import conditionality

The coefficients show that in the four years of analysis of earned value greater than 1, but the same number of years, this value was less than 1. In the year 2011 was achieved almost identical value of imported feed and exported fish with about 8.2 million. The worst result was achieved in 2014. In that year, feed for salmonids was imported in the amount of BAM 9.3 million, and BAM 7.8 million was exported of trout and trout products. The movement of the coefficient was partly caused by the prescribed zero-emission quotas for EU exports to the market, which increased from 60 tonnes net weight in 2011 to 500 tonnes in 2017. Savić et al (2018) also states that since 2013 there have been no export of live trout to Croatia recorded. On the deviation at this coefficient can also affect the momentum of exports and imports, because sometimes import of feed is recorded in the previous while the fish fed with that fed is exported in the following year. Aggregate coefficient for all 9 years is 1.06 and it shows that imported salmonid feed adds value to BiH and on the basis of its production exports by 6% more trout, ignoring the amount of feed consumed on the domestic market.

Table 4 shows the ratio of imported feed prices and export prices of trout and trout products. From the observed parameters biggest oscillations were present in imported prices of feed. The price of exported trout and trout products had the most intensive rate changes and has grown at an average annual rate of 2.72%, while the price of imported feed for salmonids had less intensive growth rate (1.38%).

Table 4. The ratio of export prices of trout and trout products and imported feed prices for salmonids (2010-2018)

Fish	Average (BAM/kg)	Variation interval		CV (%)	Variation rate (%)
		min	max		
Export price of trout and trout products	5.42	4.70	5.83	6.13	2.72
Import price of feed for salmonids	2.45	2.15	2.91	8.67	1.38
Ratio between the price of trout and trout products and production of trout and feed for salmonids	2.22	1.87	2.43	6.99	1.32

Source: Own calculations based on the data of the Indirect Taxation Authority of B&H.

The export price of trout and trout products was 2.2 times higher than the import price of salmonid feed. In the first three years the price of exports was constantly growing as well as in the last three years of the analysis. In the 2013-2015 oscillations have been recorded, and in this respect the ratio was in favour of the export price of trout and trout products. The rate of change in this sub-period was negative (-7.06%). The worst ratio was in 2015 (1.87). In the

2010-2012 sub-periods, the ratio of the price of trout and trout products from trout and feed prices for salmonids grew at a rate of 3.15%, and in the sub-period 2016-2018 at a rate of 4.18%.

Since the factor of conversion consumption of feed for 1 kg of fish weight gain is relatively stable (Fry et al, 2018), the oscillations in the ratio between prices of feed and fish are directly reflected on the economic position of trout breeders. A more favourable relationship allows them to make better profits, and vice versa.

Conclusion

Bosnia and Herzegovina is highly depended on import in terms of feed for fish, especially in the case of salmonids that are intensively cultivated. Of the total amount of import of fish dominates feed for salmonids in amount of 83.95%. Feed was dominantly imported from Italy, besides other countries. The most critical year in terms of export of products was 2013 and 2014 when BiH lost the market in Croatia due to integration in the EU zone. However, in spite of this salmonids recorded during the entire year a surplus in international trade with the fact that from 2015 surplus has a downward trend that is it can be said worrying increase of import of trout in BiH in the last two years of analyses. In 2018, imports were almost three times higher than imports in 2017. The coefficient of value of imports of feed for salmonids and the export of trout and trout products varied from year to year, and from 2016 they show a tendency of decline which leads to the deterioration of the economy of production. In the coming period should be directed towards producing products of higher added value, and development of new products. From the aspect of foreign currency inflow of import feed for salmonids is acceptable because the adding value secures the export of trout which is higher in value than the value of imported feeds. Besides that, one part of the fish is used to satisfy the domestic consumption. Taking in consideration on the components used for making the fish feed it is not realistic that the import can significantly substitute the domestic production of feed for salmonid. The economical position of salmonid producers improved during the analysed period because of the change in the ratio between the prices of exported trout and trout product and the price of feed for salmonids are going in their favour. This example demonstrates that every import is not, in itself, unfavourable for the importing country. If, as is the case of analysed trout production, it manages to add bigger values by import components, and based thereon realizes

higher export value, positive effects are multiple (better utilization of other resources, employment of local labour force, positive foreign trade and foreign exchange balance).

References

Čaldarović, O. (2007). *Sociological study on preferences in consumption of fish and other fishery products of the population of Republic of Croatia.* University of Zagreb.

Franičević, V. (2012). *Croatina fish consumer preferences with specific focus on fish originated from aquaculture*. Ph.D. thesis, Split, Croatia.

Fry, P.J., Mailloux, A.N., Love, C.D., Milli, C.M. & Cao, L. (2018). *Feed conversion efficiency in aquaculture: do we measure it correctly?* Environmental Research Letters 13, 024017. https://doi.org/10.1088/1748-9326/aaa273.

Opačak, A., Florijančić, T., Tolušić, Z., Kralik, I. & Lužaić, R. (2007). *Preferences of freshwater fish consumers in the Republic of Croatia*. Book of Proceedings, 42nd Croatian & 2nd International Symposium on Agriculture, p. 175.

Ostojić, A., Savić, N. & Vaško, Ž. (2017). Consumer attitudes on buying fish in Banja Luka. *Economics of Agriculture*, Vol. LXIV, (1), 129-140.

Ostojić, A. & Vaško, Ž. (2019). *Projections of self-sufficiency of Bosnia and Herzegovina in basic types of meat*. Sustainable agriculture and rural development in terms of the Republic of Serbia strategic goals realization within the Danube region: Sustainability and multifunctionality, 13-14th December 2018, Thematic Proceedings, International Scientific Conference, Institute of Agricultural Economics, Belgrade, Serbia, 50-67.

Pavličević, J., Ostojić, A., Glamuzina, B., Savić, N., Rozić Irena & Kanlić, Vera, (2015). *Foreign-trade exchange of Bosnia and Herzegovina with fishing products*. VII International Conference "Water & Fish", Conference proceedings, June 10-12, Faculty of Agriculture, University of Belgrade, Serbia, 407-413.

Pavličević, J., Savić, N. & Glamuzina, B. (2014). *Akvakultura i ribarstvo, stanje i perspektive u Bosni i Hercegovini*. Univerzitet u Mostaru, Agronomski i prehrambeno tehnološki fakultet, Mostar.

Savić, N., Babić, R., Ostojić, A. & Vaško, Ž. (2018). *Dužičasta pastrmka - gajenje, tržište i ekonomika*. Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka.

Original scientific paper

Comparative financial analysis of crop, livestock and mixed agricultural producers' profitability in the Republic of Srpska

Tamara Stojanović

University in Banja Luka, Faculty of Agriculture, Bulevar Vojvode Petra Bojovica 1 A, Bosnia and Herzegovina

Corresponding author: Tamara Stojanović, tamara.stojanovic@agro.unibl.org

Abstract

The aim of this research was to compare profitability indicators between three major agricultural sub-sectors in the Republic of Srpska: crop producers, livestock producers and mixed producers. The analysis was based on the structure of total revenues, their distribution and profitability ratios such as ROA, ROE and ROIC. The analysis covered financial data of approximately 150 crop producers, 84 livestock producers and 43 mixed agricultural producers in the six-year period (2010-2015).

Scientific-research methods used in this analysis include data classification, calculation of financial indicators, time and special comparison, descriptive statistics and method of inference. The results of analysis show that the profitability of all agricultural producers is generally low, especially for livestock producers. Regarding the structure of total revenues, they completely relate to operating revenues, while operating expenses make 97% of total revenues for all three sub-sectors. Among other expenses, financial expenses are dominant, but almost insignificant in relation to total revenues. This clearly indicates that loans are not available to agricultural producers due to their low profitability and that we can see in the low participation of net profit in total revenues. Profitability ratios have provided similar results. Thus, ROIC was 0.00% for all producers during the whole period, while ROA and ROE indicators have been generally low. Although these results indicate weak profitability and capital structure of all agricultural producers in the Republic of Srpska, on the other hand, they show higher profitability of mixed agricultural producers, and it would be interesting to investigate the reasons behind this in the future.

Key words: agricultural producers, profitability, indicators, comparison

Introduction

There is no doubt that agriculture has an important impact on the economy and the development of the Republic of Srpska (RS). Its significance is evident by its participation in total gross domestic product[1] and gross domestic value, the number of employees it engages and by the fact that it provides food and other agricultural products to its population. In addition, the role of agriculture as the provider of raw materials for the development of RS' food industry should not be underestimated at all. In order to accomplish their mission agricultural companies, and agricultural sector as a whole, should be sustainable. According to the Food and Agriculture Organization (FAO) (1989), sustainable agriculture consists of five major attributes: (1) it conserves resources, (2) it is environmentally non-degrading, (3) it is technically appropriate, (4) it is economically and (5) socially acceptable (Kassie et al., 2012). As conserving resources means earning profits, the profitability of agricultural producers is definitely one of the factors affecting their sustainability and that is why it is a subject matter of our analysis.

Financial analysis of companies' profitability is usually based on time and spatial comparison (see: Rodić et al., 2011). Time comparison shows trends and tendencies in development and achieving business results (profits). In addition, it enables identification of moment when unfavorable tendencies and their causes occurred and how they affected the performance in the following period. Spatial comparison is used in estimating the position of a company among competitors. When selecting a benchmark there are two options: (1) to use the best company in the sector as a benchmark, or (2) to use all the companies from the sector, i.e. a sector's averages. Three major agricultural sub-sectors in the RS (crop producers, livestock producers and mixed producers) have been used as three groups of competitors. The analysis covered financial data of approximately 150 crop producers, 84 livestock producers and 43 mixed agricultural producers in the six-year period (2010-2015).

Regarding similar researches in the RS and B&H, Stojanović and Stojanović (2015) carried out the analysis of the general financial position of the agricultural sector in the RS, as a whole, for the three year period (2010-2012) without analyzing sectors within the industry. Stojanović (2016) expanded this analysis by the comparative financial position analysis among individual agricultural sectors for the same period (2010-2012). Vaško et al. (2016) analyzed only revenues, costs and business results of RS' agricultural companies in the 2007-2014 period. Later,

[1] In the period 2007-2014, agriculture's participation in total RS' GDP was between 8.3% and 11% (see: Vaško et al., 2016).

Vaško et al. (2018) analyzed financial performance of the companies in the agricultural sector and food industry in the RS. In addition, Stojanović and Drinić (2018) researched the financial position of livestock producers in the RS comparing it to the sector's averages.

In Serbia, Vukoje and Obrenović (2001) analyzed financial result and financial position of rural producers in Vojvodina in 1999 and 2000. Vukoje (2002) performed the analysis of basic financial indicators of Vojvodina's agricultural and food processing companies in 2001. Later, Vukoje (2009) made the comparative analysis of basic profitability indicators of a complex agricultural company in Vojvodina. In addition, Vuković, Veselinović and Drobljanović (2016) presented the comparative analysis of profitability of 23 medium-sized agricultural enterprises, which operates in West-Backa County. In Croatia, Hadelan et al. (2011) performed the financial analysis of Croatian food industry in the condition of recession for the year 2009. In Tanzania, Mugula and Mishili (2018) performed the profitability analysis of sustainable agriculture practices to smallholder maize farmers in Kilosa District.

The aim of this research was to compare profitability indicators, based on primary data sources, between three major agricultural sub-sectors in the RS: crop producers, livestock producers and mixed agricultural producers in order to identify some trends but also to see which sub-sector had the best profitability indicators during the period.

Materials and Methods

Financial profitability can be measured by many indicators, such as: (1) the indicators of total revenues structure and their distribution (the participation of operating and non-operating revenues in total revenues; the coverage of operating, financial and other expenses by total revenues and the participation of operating and net profit in total revenues); (2) earnings analysis (operating earnings, financial earnings, non-operating earnings, profit before taxes, net profit), and (3) profitability ratios (ROA, ROE and ROIC). Our profitability analysis included the analysis of total revenues structure and their distribution and profitability ratios analysis. We have excluded the earnings analysis since it includes absolute figures, but because there is a great variability among individual companies, absolute figures are incomparable. Therefore, we believe that comparative analysis among sub-sectors would provide better conclusions if it is based on relative figures.

Besides calculating the structure of total revenues and their distribution, our analysis included the calculation of profitability ratios such as return on assets (ROA); return on equity (ROE)

and return on invested capital (ROIC). Formulas for calculating these ratios are commonly known, but we refer to those that can be found in: Rodić (1991), Žager and Žager (1999), Bragg (2002), Wheeling (2008), Gibson (2009), Kramer and Johnson (2009), Ivaniš and Nešić (2011), Rodić et al. (2011) and Mikerević (2011). The analysis also included trend analysis, as well as the comparative analysis. In summary, our profitability analysis includes:

1. trend analysis of financial profitability indicators in the six year period (2010- 2015) in order to identify trends for each agricultural sub-sector, and
2. the comparative analysis of the above mentioned profitability indicators (in average) between three sub-sectors and the agricultural sector as a whole.

Results and Discussion

The structure of total revenues and their distribution

The structure of total revenues and their distribution have been analyzed through the participation of operating and non-operating revenues in total revenues, the coverage of operating, financial and other expenses by total revenues and the participation of operating and net profit in total revenues. Since these indicators have had insignificant variations throughout the period, they are presented in their average values in the following Table 1.

Table 1. The Structure of Total Revenues and Their Distribution, 2010-2015 (average, in %)

No	Item	Crop producers	Livestock producers	Mixed agricultural producers
1	Operating revenues	99.69%	99.73%	99.86%
2	Non-operating revenues	0.03%	0.01%	0.00%
3	Operating expenses	96.97%	96.78%	97.23%
4	Financial expenses	0.28%	0.34%	0.03%
5	Non-operating expenses	0.15%	0.04%	0.02%
6	Operating profit/loss	0.78%	-0.40%	0.94%
7	Net profit/loss	0.84%	0.85%	0.97%

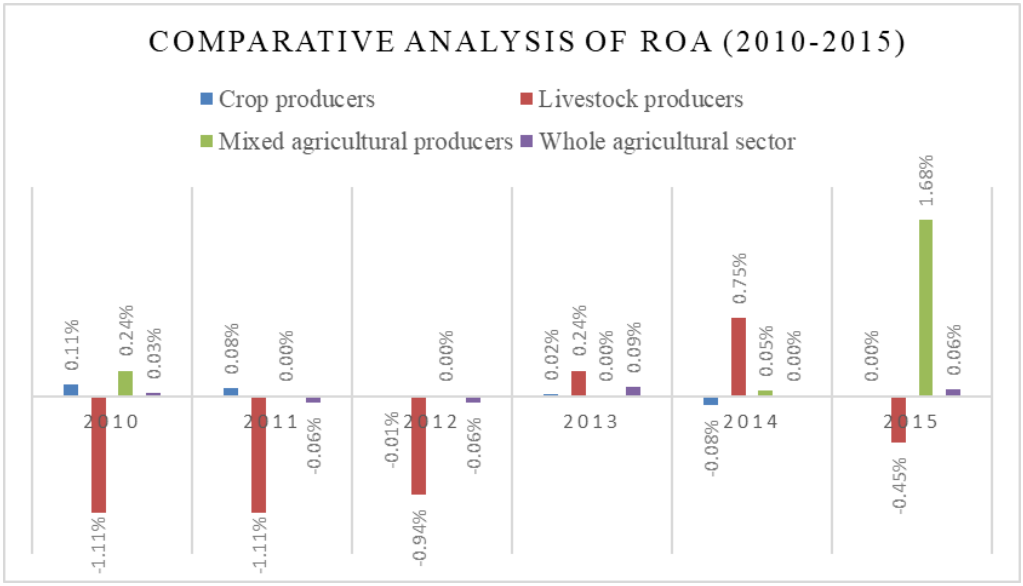
Regarding the structure of total revenues, they completely relate to operating revenues (from 99.69 to 99.86 %), while operating expenses make approximately 97% of total revenues for all three sub-sectors. Among other expenses, financial expenses are dominant, but almost insignificant in relation to total revenues (from 0.03 to 0.28 %). This clearly indicates that loans are not available to agricultural producers, most probably due to their low profitability which

can be also seen in the low participation of operating profit (from -0.40 to 0.94 %) and net profit (from 0.84 % to 0.97 %) in total revenues. Also, this situation clearly indicates that agricultural producers are facing the negative financial leverage and, therefore, financing through debt would only make already weak financial position even worse.

Profitability ratios analysis

Our analysis focused on three, most common, profitability ratios: return on assets (ROA), return on equity (ROE) and return on invested capital (ROIC). ROIC was 0.00% during the whole period for all three sub-sectors and that is why it has not been presented separately in this paper. However, this level of return on invested capital clearly indicates that the investments in agricultural sector were either insignificant or money invested did not generate any return, meaning that invested capital has not been used effectively.

Return on Assets (ROA) is an indicator of how profitable a company is relative to its total assets. ROA gives an idea as to how efficient a company's management is at using its assets to generate earnings. ROA is displayed as a percentage and is calculated by dividing operating profit by total assets. Graph 1 presents ROA for all three sub-sectors and the whole agricultural sector, in average, in the six-year period (2010-2015).



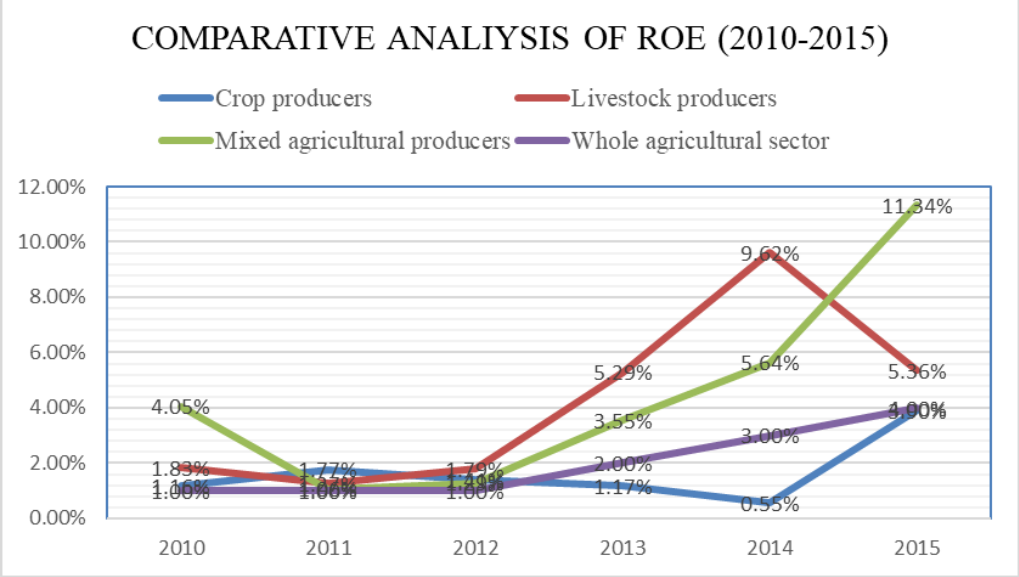
Graph 1. Comparative Analysis of ROA between three sub-sectors and the whole agricultural sector (2010-2015)

As we can see, ROA indicator was low for all three sub-sectors and the agricultural sector as a whole. However, it is obvious that livestock producers' ROA was the lowest during the period

(except in 2013 and 2014), and shows the highest variability. On the other side, mixed producers had positive ROA during the period and its levels were above the sector's averages during the whole period.

Nevertheless, as we have noticed above, these levels of ROA confirm the existence of negative financial leverage for all agricultural producers and it is an important issue. With such a negative financial leverage, every additional debt would just lead to lower levels of net profits and consequently lower returns of equity. The only way to improve such situation is to change the capital structure to the favor of equity.

Return on Equity (ROE) is considered a measure of how effectively management is using a company's own assets to create profits. ROE is expressed as a percentage and is calculated by dividing net profit by total equity. Graph 2 presents ROE for all three sub-sectors and the whole agricultural sector, in average, in the six-year period (2010-2015).



Graph 2. Comparative Analysis of ROE between three sub-sectors and the whole agricultural sector (2010-2015)

ROE indicator was higher than ROA during the whole period and for all three sub-sectors and the sector as a whole. Although these figures seem encouraging, they can also mean that capital structure is unfavorable. The reason why ROE is higher than ROA can be find in the fact that assets are to a greater extent financed through debt, meaning that the capital, in its structure, contains less equity (company's own assets) and more debt. Since agricultural producers have

lower amounts of equity in their balance sheets, we get higher ROE indicators when dividing net profits by such equities.

In contrast to ROA comparative analysis, where livestock producers had the lowest levels of this ratio during the period, now crop producers had the lowest ROE levels, while mixed agricultural producers had, again, the highest ROE levels during the whole period.

Nevertheless, these are only average[2] indicators and there is a significant variability regarding ROE among individual producers in each sub-sector.

Conclusion

The agricultural industry differs from other industries and this fact has to be taken into account. When discussing its profitability and overall performance, certain characteristics should be kept in mind such as existence of vegetation period in crop production, seasonal nature of agricultural production, slow capital turnover, special approach to performance evaluation (considering the seasonal production), etc. The analysis clearly has shown that those agricultural companies, which depend more on these specific factors are more subject to financial challenges and low performance. Since conserving resources is the manifestation of profitability, and represents one of five major attributes of sustainable agriculture, we have chosen the profitability of agricultural producers as a subject matter of our analysis.

The results of analysis show that the profitability of all agricultural producers is generally low, especially for livestock producers. Regarding the structure of total revenues, they completely relate to operating revenues, while operating expenses make 97% of total revenues for all three sub-sectors. Among other expenses, financial expenses are dominant, but almost insignificant in relation to total revenues. This clearly indicates that loans are not available to agricultural producers due to their low profitability, which can be also seen in the low participation of net profit in total revenues (from 0.84% to 0.97%). Profitability ratios have provided similar results. Thus, ROIC was 0.00% for all producers during the whole period, while ROA (in average: 0,02% - crop producers; -0,44% - livestock producers and 0.33% - mixed producers) and ROE (in average: 1.66% - crop producers; 4.19% - livestock producers and 4.49% - mixed producers) have been generally low. Although these results indicate weak profitability and capital structure of all agricultural producers in the Republic of Srpska, on the other hand, they show higher profitability of mixed agricultural producers, and it would be

[2] We have used a median as an average indicator in order to exclude the influence of extreme cases on the total population.

The reason is, most probably, the fact that capital structure is rather weak and agricultural producers are constrained to finance their business operations and investments through debt. However, because of their low returns on assets (ROA) and higher interest rates, they suffer from negative financial leverage resulting in even lower net profits, i.e. losses and weaker capital structure. The fact that, in the same circumstances, some agricultural producers (mixed agricultural producers) have better profitability indicators, it would be interesting to investigate the reasons behind this in the future as they could serve as important lessons for other producers. However, as low profitability is the reality of total agricultural sector, solutions should be looked for in systemic measures, primarily in providing a long-term and cheaper capital, but also in introducing modern and more effective production approaches and risk-oriented management.

References

Bragg, S.M. (2002). *Business Ratios and Formulas: A Comprehensive Guide.* New Jersey, John Wiley & Sons, Inc.

Gibson, C.H. (2009). *Financial Reporting & Analysis.* Eleventh Edition. Ohio: South-Western Cengage Learning.

Hadelan, L., Marijanović, B., Njavro, M. & Par, V. (2011). *Financijska analiza poslovanja hrvatske prehrambere industrije u uvjetima recesije.* Proceedings from 46th Croatian and 6th International Symposium on Agriculture, 216-220.

Ivaniš, M. & Nešić, S. (2011). *Poslovne finansije*. Univerzitet Singidunum, Beograd.

Kassie, M., Benites, J., Martinez-Vilela, A. & Holgado-Cabrera, A. (2012). *Conservation Agriculture: Environment, Farmers Experiences, Innovations, Socio-economy, Policy*. https://www.researchgate.net/publication/321611222_Conservation_Agriculture_Environment_Farmers_Experiences_Innovations_Socio-economy_Policy

Kramer, B. K. & Johnson, C.W. (2009). *Financial Statements Demystified.* McGraw-Hill, eBooks.

Mikerević, D. (2011). *Finansijski menadžment*. Banja Luka, Ekonomski fakultet.

Mugula, J. & Mishili, F. (2018). Profitability analysis of Sustainable Agriculture Practices to Smallholder Maize Farmers in Kilosa District Tanzania. *International Journal of Scientific and Research Publications,* Volume 8, Issue 4, 381-389.

Rodić, J. (1991). *Analiza bilansa*. Ekonomika, Beograd.

Rodić, J., Vukelić, G., Andrić, M., Lakićević, M. & Vuković, B. (2011). *Analiza finansijskih izveštaja*. Univerzitet u Podgorici, Podgorica.

Stojanović, T. & Stojanović, S. (2015). Finansijska analiza položaja preduzeća iz poljoprivrednog sektora Republike Srpske. *Agroznanje, 16*(4), 549-557.

Stojanović, T. (2016). *Financial Position Analysis of the RS's Agricultural Industry; Financial Position Analysis – A Case Study.* Saarbrücken: LAP LAMBERT Academic Publishing.

Stojanović, T. & Drinić, LJ. (2018). Financial position analysis of livestock production companies in the Republic of Srpska. *AgroRes 2018 Book of Abstracts*. p. 129.

Vaško, Ž., Ostojić, A., Roković, G., Drinić, Lj., Mrdalj, V., Figurek, A. & Brković, D. (2016). *Poljoprivreda i ruralni razvoj u Republici Srpskoj do 2020. godine.* University in Banja Luka, Faculty of Agriculture, Banja Luka.

Vaško, Ž., Ostojić, A. & Drinić, Lj. (2018). Financial Performance Analysis of the Companies in the Agricultural Sector and Food Industry in the Republic of Srpska. *Agro-knowledge Journal*, 19 (2), 67-78.

Vukoje, V. & Obrenović, D. (2001). Analiza finansijskog rezultata i finansijskog položaja ratarske proizvodnje u Vojvodini. *Letopis naučnih radova,* 25 (1-2), 55-65.

Vukoje, V. (2002). Analiza osnovnih finansijskih pokazatelja poljoprivrede i prehrambene industrije Vojvodine. *Letopis naučnih radova,* 26 (1), 76-85.

Vukoje, V. (2009). Komparativna analiza osnovnih pokazatelja uspeha složenog poljoprivrednog predeuzeća. *Letopis naučnih radova,* 33 (1), 19-27.

Vuckovic, B., Veselinovic, B. & Drobnjakovic, M. (2016). Analysis of profitability of selected agricultural enterprises in the autonomous province of Vojvodina, Republic of Serbia. *Actual problems of economics*, Vol 2 (176), 147-159.

Wheeling, B. (2008). *Introduction to Agricultural Accounting.* New York: Thomson Delmar Learning.

Žager, K. & Žager, L. (1999). *Analiza financijskih izvještaja*. Zagreb: Masmedia.

Компаративна анализа приносног положаја биљних, сточарских и мјешовитих пољопривредних произвођача у Републици Српској

Тамара Стојановић

Универзитет у Бањој Луци, Пољопривредни факултет, Булевар војводе Петра Бојовића 1 А, Босна и Херцеговина

Аутор за кореспонденцију: Тамара Стојановић, tamara.stojanovic@agro.unibl.org

Сажетак

Циљ овог истраживања је било поређење показатеља профитабилности између три највећа пољопривредна под-сектора у Републици Српској: биљних, сточарских и мјештовитих пољопривредних произвођача. Анализа је заснована на структури и распореду укупних прихода, те показатељима профитабилности као што су: принос на имовину (ROA), принос на властити капитал (ROE) и принос на инвестирани капитал (ROIC). Анализом су обухваћене финансијске информације за приближно 150 биљних произвођача, 84 сточара и 43 мјешовита пољиопривредна произвођача током шестогодишњег периода (2010-2015). Научно-истраживачи методи кориштени у овој анализи укључују: класификацију података, израчунавање финансијских показатеља, временску и просторну компарацију, дескриптивну статистику и метод закључивања.
Резултати анализе су показали да је профитабилност свих пољопривредних произвођача генерално на ниском нивоу, посебно када је ријеч о сточарским произвођачима. Што се тиче структуре прихода, они се у цјелини односе на пословне приходе, док пословни расходи чине 97% укупних прихода за сва три под-сектора. Што се осталих расхода тиче, доминирају финансијски расходи, али су они готово безначајни у поређењу са укупним расходима. Ово јасно указује на то да кредитна средства нису расположива пољопривредним произвођачима због њихове ниске профитабилности, што се може видјети и у ниском учешћу нето добити у укупним приходима. Рација профитабилности су дала сличне резултате. Тако је ROIC био 0.00% код свих произвођаче током читавог периода, док су ROA и ROE показатељи били генерално ниски. Иако ови резултати указују на слабу профитабилност и структуру капитала код свих пољопривредних произвођача у Ребулици Српској, они, са друге стране, указују на вишу профитабилност

мјешовитих пољопривредних произвођача, због чега би, у будућности, било интересантно истражити разлоге који стоје иза ове појаве.

Кључне ријечи: пољопривредни произвођачи, профитабилност, показатељи, поређење

Original scientific paper

Consumer habits and opinions toward organic products in Banja Luka

Nataša Tomić, Nemanja Jalić, Nikola Bulović

Faculty of Agriculture, University of Banja Luka, Banja Luka, Bosnia and Herzegovina

Corresponding author: Nataša Tomić, natasatomic995@gmail.com

Abstract

Organic production is nowadays one of the measures that increases the sustainable development of agriculture and customers are choosing organic products more and more. This type of production is in development in Bosnia and Herzegovina and this paper focuses on consumer habits and decision making processes during purchase. The aim of this paper was to determine consumer preferences and attitudes toward organic products in Banja Luka. The research was conducted during March using structured questionnaire which contained 21 questions. Survey was carried out using Google forms among customers of shop specialized in sale of organic products. Totally, 48 consumers of organic products were questioned and all data were processed in MS Excel using basic mathematical - statistical methods. The results of survey showed that 75 % of all respondents thought that organic products are products without any chemicals or pesticides which have organic certificate, and the word 'healthy' was the first association on the term organic in 64,6% of cases. Health and the quality were the most important factors influencing the purchase. Consumers also agreed that bigger surfaces should be under organic products and that offer is not satisfying. Based on the results it can be concluded that larger arable areas should be under organic products, that suitable management of certification should be developed and that these products should have suitable promotion. Also, organic production should also be supported more through agrarian policy measures and through subsidies.

Key words: Organic products, consumers, opinions and preferences, Banja Luka

Introduction

Demand for food and agricultural products increases as our population continues to grow and expand. The world is facing an ever increasing pressure to develop and adopt another green revolution for meeting its food requirements to feed the population without depleting Earth‘s resources, polluting its environment, or causing irreversible damages to the health of our ecosystem. There are many technologies that have emerged as promising sustainable agriculture practices that could possibly meet expected demand with improved environmental protection. Organic agriculture has been touted and promoted as a farming system that is consistent with the goals of sustainable agriculture and offers many environmental benefits through its management practices that enhance biodiversity, restore and maintain the natural ecological harmony (Lin et al., 2009).

The increasing environmental concerns about intensive production processes and increasing consumer demand for higher quality food products, and increasing consumer dissatisfaction with conventional food are important factors which make organic food products an interesting consumption option. The growth of the organic food product depends on consumer perception that the quality of organic food product is higher, the taste is better, and they are more environmentally friendly than conventional food products (Brunso et al., 2002). Organic agriculture production in the European Union (EU) is subject to a certain regulation since 1991. The aims are (i) to establish the requirements for agriculture products and foodstuffs bearing a reference to the production methods used in organic farming, (ii) to support the development of organic agriculture in the European Union, and (iii) to inform consumers, and other actors in the food chain about the merits of organic farming. Thus, a clear understanding of consumers' choice and underlying motivations to purchase organic food products instead of conventional ones will assist EU policy makers as they formulate and implement the EU Action Plan on organic food and farming (Irandoust, 2016).

Bosnia and Herzegovina is in the initial stage of organic production development. The lack of adequate legal regulations is emphasized and without that there is no regular supply and demand for organic food. Bosnia and Herzegovina has not even used the approximate resources that has in the domain of organic agricultural production. This is best explained by the fact that even about 40% of the land is not in use, which makes it an excellent basis for fast inclusion in the organic production system. Demand for this type of products is in a slight rise, but the demand is mostly satisfied from import, due to the lack of wide range of domestic organic

products. According to Ministry of Foreign Trade and Economic Relations, in 2016 there were only 659 hectares under organic production in Bosnia and Herzegovina, which is more than in previous years (in 2015 there were 576 hectares and in 2014 353 hectares). According to the Fotopoulos and Krystallis (2002), as cited in Vehapi and Dolićanin (2016), consumers of organic food are mostly women, middle or older aged, married persons with children in households. Also, as claimed by Riefer and Hamm (as cited in Vehapi and Dolićanin, 2016), age of children is also important factor, because transition to adolescents age creates conditions for reduction of consumption of organic food, because of preferences of minors toward conventional products. Lockie et al. (2002) claim that purchase of organic food is connected to the higher level of education and higher income.

The main goal of this paper was to determine customers opinions, habits and frequency of purchase of organic products as well as motives for purchase.

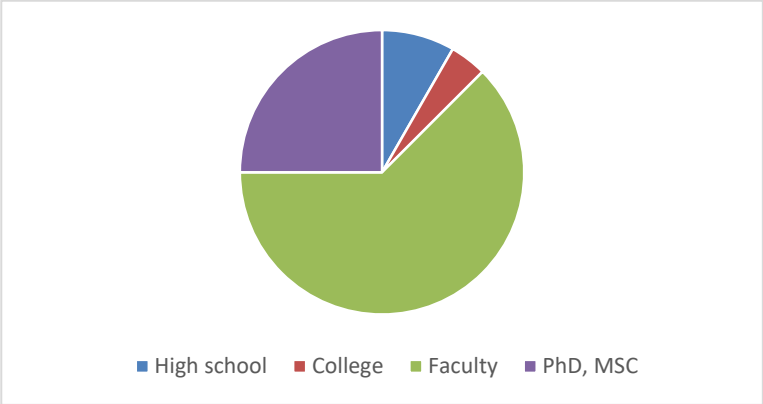
Material and Methods

For the sake of this paper, three methods were used: desk research in order to provide all necessary data about organic production and method of interrogation and field research. The field research was conducted using structured questionnaire that contained 21 questions. The questionnaire was divided in 4 parts: first one contained general information about respondents, second contained questions about consumer associations and frequency of purchase, while the third one contained questions about factors that influence purchase. The fourth part included questions about consumer opinions toward organic products. The survey was carried out using Google forms among customers of shop specialized in sale of organic products in Banja Luka, during March 2019. Totally, 48 consumers of organic products were questioned and all data were processed using standard mathematical-statistical methods. All data were processed using MS Excel program.

Results and Discussion

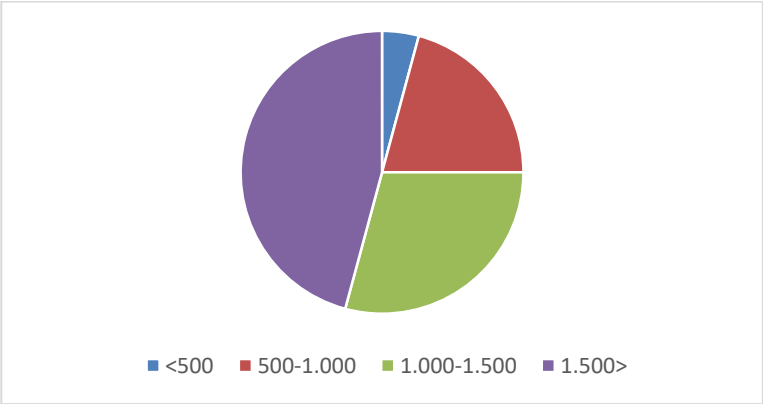
General information about respondents - of total 48 respondents, 93.8% were female and 6.3% were male. The most of the respondents (81.3%) were between 31 and 50 years old, while 12.5% were between 18 and 30 years old. In range between 51 and 65 years old, only 6.3% of total number of respondents were represented while there were no respondents older than 65.

When it comes to education, more than a half of respondents were highly educated people (62.5%), while 25% had MSc or PhD (Graph 1).



Graph 1. Level of respondent's education

One half of respondents or 50% came from families with 4 members, 31.3% were from families with 3 members, 10,4% were from families with two members while 6.3% of respondents declared that they came from families with more than 5 members. The single persons were at least represented with only 2.1%. More than three quarters of total number of consumers (81.3%) were employed, while there was 14,6% of unemployed and 4.2% of retirees. Speaking of incomes of consumers, 45.8% of them declared that their incomes were higher than 1,500 BAM, 29.2% declared incomes between 1,000 and 1.500 BAM (Graph 2).



Graph 2. Level of incomes

Association and frequency of purchase - in 75% of cases, customers said that they think about organic products as of products that were made without any chemicals, pesticides that own organic certificate. Only 12.5% of respondents said that they think about organic products as

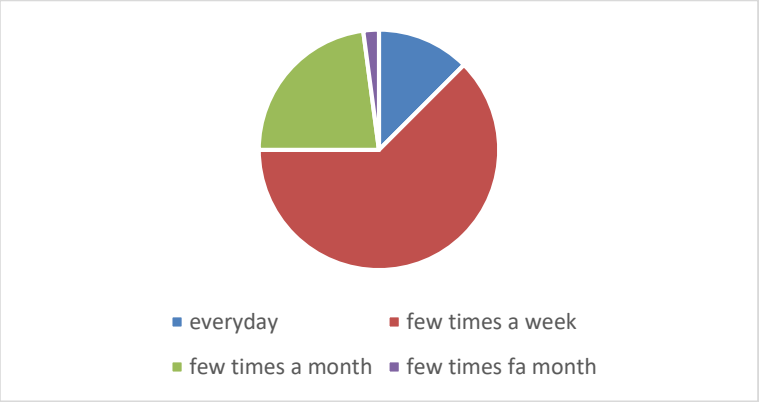
of products without any chemicals or pesticides but without certificate. Further, 8.3% of respondents though that organic products were made in order to preserve nature, animal welfare and that they are non – GMO, while 4.2% declared organic products as products that are eco or bio. Stefanić et al. (2001) claim that consumers percipiate organic products as healthy, environmentally safe and produced without chemicals or pesticides.

In 64.6% of cases word 'health' was the first word that reminded respondents on organic products. Words such as 'non-sprayed' or quality followed (Table 1). Some studies like the one Zanoli and Naspetti (2002) identify health as a main factor influencing the purchase of organic products However, Padel and Foster (2005) claim that consumers associate organic at first with fruit and vegetables and then with healthy diet, rather that only with a health.

Table 1. Associations on term organic products

1.	Word	%
2.	Health	64.6%
3.	Non-sprayed	12.5%
4.	Quality	4.2%
5.	Vegetables	4.2%
6.	Organic	2.1%
7.	Natural	2.1%
8.	Tasty	2.1%
9.	Grain	2.1%
10.	Childhood	2.1%
11.	Reliability	2.1%
12.	Clean	2.1%

Accordingly, 58.3 % of questioned consumers declared that they bought organic products because of health. The next were the respondents who declared that they bought organic products because of children (35.4%), followed by ones that buy them because of animal and plant welfare (4.2%) and the ones that bought them because of taste (2.1%). According to the Zander and Hamm (2009), 'personal health' was found to be by far the most frequently named motive, followed by 'environmental protection' and 'animal welfare'. More than a half of respondents (62.5%) declared that they bought organic product few times a week, followed by the ones who bought them few times a month (Graph 3).



Graph 3. Place of purchase of organic products

Factors influencing the purchase - Health was the most important factor affecting the purchase, followed by quality, taste, composition and origin (Table 2).

Table 2. Factors influencing the purchase of organic products

	Factor	Mean	Std. Deviation
1.	Quality	4.66	0.47
2.	Taste	4.37	0.67
3.	Composition	4.29	0.74
4.	Origin	4.08	0.76
5.	Certificate	4.0	0.85
6.	Price	3.47	0.92
7.	Package	2.81	1.26
8.	Brand	2.62	1.14
9.	Health	4.68	0.47

According to the Kuhar and Juvančić (2006) taste appears to significantly affect the consumer preferences to purchase because consumers perceive these categories of produce as having superior taste compared to the conventional ones and these respondents are more likely to be among buyers. Research conducted by Jovanović et al (2016) came to the similar results regarding the price of organic food, because the respondents were of the opinion that domestic organic food price is high and that it is more expensive than conventionally produced food.

Opinions toward organic products - in opinion of most respondents, larger areas should be under organic production. Also, respondents agreed that prices of organic products are higher than conventional products and that there is a need for adequate labels on organic products. Respondents also declared that they are not faithful to only one brand and that consumption of organic products is not a trend (Table 3).

Table 3. Consumers thought on promotion, offer and prices of organic products

	Statement	Mean	Std. Deviation
1.	Larger areas should be under organic production	4.68	0.51
2.	Prices of organic products are higher than conventional products	4.52	0.65
3.	There is a need for adequate labels on organic products	4.39	0.57
4.	Promotion is important for purchase of organic products	4.18	0.70
5.	Organic products have more nutrients than conventional products	4.1	0.83
6.	The quality of organic products is satisfying	3.63	0.61
7.	Exposure of organic products at sales point is adequate	3.1	1.02
8.	The offer of organic products is satisfying	2.81	1.02
9.	Prices of domestic organic products are higher than prices of imported products	2.48	1.03
10.	Promotion of organic products is adequate	2.29	0.82
11.	I am faithful to only one brand of organic products	2.00	0.68
12.	Consumption of organic products is only a trend	1.73	0.84

Similar research conducted by Cerjak et al. (2010) showed that consumers in Bosnia and Herzegovina are satisfied with the quality, assortment and prices of organic food products, but at the same time they are extremely unsatisfied with sale services. Research conducted by Jovanović et al (2016) found out that more than 50% of respondents in Montenegro are of the opinion that domestic producers do not have a wide range of organic products and 73.6% of respondents state that domestic producers do not produce sufficient quantities of organic food that would meet the demand of consumers. Brčić-Stipčević et al. (2010) claim that organic products have higher prices comparing to the conventional ones because of the various reasons. One of them is that conventional products are too cheap because indirect ecological or social costs are not included. Consumers are mostly informed about organic products and it's supply on the internet (47.9%), then through recommendations of acquaintances (33.3%) and lastly on place of purchase (18.8%).

Conclusion

Organic production is a tool to achieve sustainable development in agriculture and is nowadays required among customers. Organic production is still in development and in rise in Bosnia and Herzegovina, with only 659 hectares being sown with organic products. Research conducted in Banja Luka, among 48 customers of organic products showed that they thought that organic products were without chemicals or pesticides with appropriate certificate proving that, that they were healthy and tasty with more nutrients comparing to conventional products. Most respondents bought them because of a health few times a week. Quality and taste were the most important factors that determined the purchase of these type of products, while brand was the less important. Respondents also thought that more arable land should be under this production, that these products should have proper promotion and labels. It can be concluded that consumers had positive attitudes toward organic products and that demand shall increase more in next years. But in order to do so, organic production should be supported more through subsidies and agrarian policy, proper certification system and legislative accompanying this production should be developed. Promotion of organic products and their better visibility on sales point is also very important as well as building of even higher awareness about importance of organic products among customers.

References

Brčić-Stipčević, V., Petljak, K. & Guszak, I. (2010). *Što utječe na kupovinu ekoloških prehrambenih proizvoda?* Proceedings of 2nd International Conference "Vallis Aurea - focus on: Regional Development", Polytechnic of Pozega, Croatia & DAAM International Vienna, Austria, Požega.

Biing-Hwan L., Steven, T.Y., Chung L.H. & Travis A.S. (2009). U.S. Demand for Organic and Conventional Fresh Fruits: The Roles of Income and Price. *Sustainability*, 1, 464-478. doi:10.3390/su1030464.

Brunso, K., Fjord, T. A. & Grunert, K. (2002). *Consumers' food choice and quality Perception*. Working paper 77, The Aarhus School of Business.

Cerjak, M., Mesić, Ž., Kopić, M., Kovačić, D. & Markovina, J. (2010). What motivates consumers to buy organic food – comparison of Croatia, Bosnia Herzegovina and Slovenia. *Journal of Food Products Marketing,* 16(3), 278-292.

Irandoust, M. (2016). Modelling consumers' demand for organic food products: The Swedish experience. I*nternational Journal of Food and Agricultural Economics*, Vol. 4, No. 3, 77-89.

Jovanović, M., Joksimović, M., Kašćelan, Lj. & Despotović, A. (2016). Consumer attitudes to organic foods: evidence from Montenegrin Market. *Agriculture & Forestry*, Vol. 62 Issue 4: 223-234

Kuhar, A. & Juvančić, L. (2006). What determines integrated and organic fruit and vegetable consumption in Slovenia? *Jahrbuch der Österreichischen Gesellschaft für Agrarökonomie*, Vol. 15, 23-33.

Lockie, S., Lyons, K., Lawrence, G. & Mummery, K. (2002). Eating 'Green': Motivations Behind Organic Food Consumption in Australia. *Sociologia Ruralis*, Vol 42, Number 1, 23-40.

Lin, B., Yen, S., Huang, C. & Smith, T. (2009). U.S. Demand for Organic and Conventional Fresh Fruits: The Roles of Income and Price. *Sustainability,* Vol. 1, 464-478.

Ministarstvo vanjske trgovine i ekonomskih odnosa Bosne i Hercegovine (2018). *Godišnji izvještaj iz oblasti poljoprivrede za Bosnu i Hercegovinu za 2017. godinu*.

Padel, S. & Foster, C. (2005). Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food. *British food journal*, 107(8), 606-625.

Stefanić, J., Stefanić, E. & Haas, R. (2001). What the customers really want: organic food market in Croatia. *Bodenkult*, Vol. 52, No. 4, 243-248.

Vehapi, S. & Dolićanin, E. (2016). Analiza marketing instrumenata domaćih proizvođača organske hrane. *Marketing*, Vol. 47, br. 1, 29-41.

Zanoli, R. & Naspeti, S. (2002). Consumer Motivations in the Purchase of Organic Food. *British Food Journal*, Vol. 104, No. 8, 643-653.

Zander, K. & Hamm, U. (2009). *Farmer Consumer Partnerships: Information search and decision making – the case of ethical values of organic products*. CORE Organic Project Series Report.

Navike i mišljena potrošača u Banja Luci o organskim proizvodima

Nataša Tomić, Nemanja Jalić, Nikola Bulović

Poljoprivredni fakultet, Univerzitet u Banjoj Luci, Banja Luka, Bosna i Hercegovina

Autor za korespondenciju: Nataša Tomić, natasatomic995@gmail.com

Sažetak

Organska proizvodnja je danas jedna od mjera kojom se povećava održivi razvoj u poljoprivredi, a sami kupci sve više i više biraju organske proizvode. Ovaj vid proizvodnje je tek u razvoju u Bosni i Hercegovini. Ovaj rad se fokusira navike potrošača procese koji utiču na kupovinu ovih proizvoda. Cilj rada jeste određivanje preferencija i stavova potrošača prema organskim proizvodima na području Grada Banja Luka. Istraživanje je sprovedeno tokom marta putem struktuisanog upitnika koji je imao 21 pitanje. Upitnik je distribuiran kupcima prodavnice specijalizovane u prodaji organskih proizvoda putem Google formsa. Ukupno je anketirano 48 potrošača organskih proizvoda i svi podaci su obrađeni uz pomoć MS Excela i statističkog paketa SPSS korištenjem standardnih matematičkih i statističkih metoda. Rezultati su pokazali da 75% ispitanika smatra organske proizvode proizvodima koji ne sadrže hemijska sredstva i pesticide i koji za to posjeduju organski certifikat, a riječ ‘zdravo’ je bila prva asocijacija na pojam organski proizvod u 64,6% slučajeva. Zdravlje i kvalitet su bili najvažniji faktori koji su uticali na kupovinu ovih prizvoda. Potrošači su se složili da bi i veće poljoprivredne površine trebale biti pod organskom proizvodnjom te da ponuda nije zadovoljavajuća. Na osnovu rezultata se može zaključiti da bi veće površine trebali biti pod organskom proizvodnjom, da bi se trebao razviti odgovarajući sistem certifikacije te da bi ovi proizvodi trebali imati odgovarajuću promociju. Takođe, organska proizvodnj bi trebala biti podržana kroz mjere agrarne politike i politike podsticaja.

Ključne riječi: Organski proizvodi, potrošači, mišljenja i preferencije, Banja Luka

Original scientific paper

The FADN as an analytical tool in EU and Serbia

Mirjana Bojčevski[1], Zorica Vasiljević[2], Vlado Kovačević[3]

[1] Adviser, Ministry of Agriculture, Forestry and Water Management, Serbia

[2] Full professor, Faculty of Agriculture University of Belgrade, Serbia

[3] Scientific associate, Institute of Agricultural Economics Belgrade, Serbia

Corresponding author: Mirjana Bojčevski, mirjana.bojcevski@minpolj.gov.rs

Abstract

Farm Accountancy Data Network (FADN) is one of the most reliable data sources for economic analysis in the agriculture. The FADN methodology enables to extrapolate the data on economic results based on the sample farms and compare the relevant indicators of all EU member states. The main income indicator used by FADN is Farm Net Value Added (FNVA) per holding or per Annual Working Unit (AWU). Farm net value added (FNVA) is used to remunerate the fixed factors of production (labour, land and capital). In order to obtain a better measurement of the productivity of the agricultural workforce taking into account the diversity of farms, FNVA is also calculated by annual work unit (AWU - work of one person occupied full time on a farm). In the process of EU accession Serbian agricultural sector is obliged to align a set of regulations and standards and adopt certain requirements compliant with the objectives of the Common Agricultural Policy (CAP), inter alia, to establish Farm Accountancy Data Network (FADN).

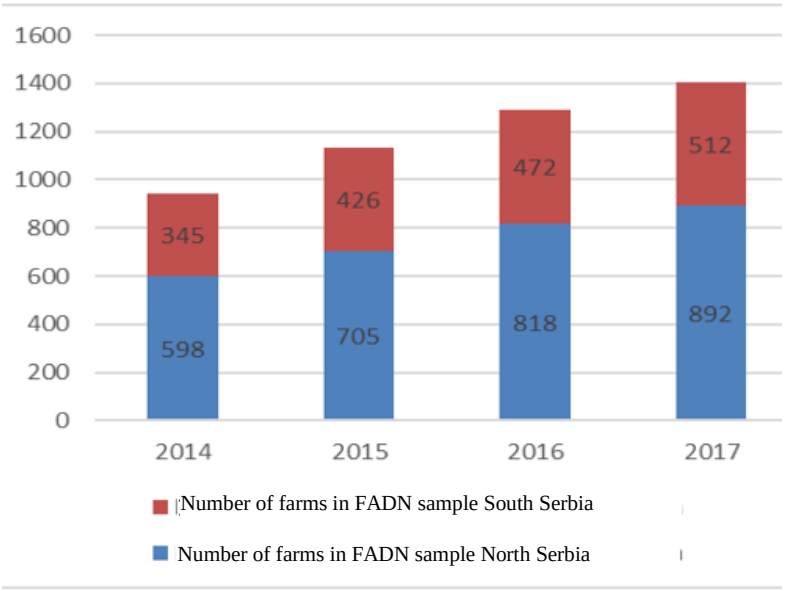
This paper provides the comparative analyses on farm income based on FNVA in 2017. and classification of the holdings by economic size and type of farming. According to the paper results the FNVA is proven to be reliable indicator allowing comparative analyses between different EU countries.

Key words: FADN, FNVA, Standard output, AWU

Introduction

The Farm Accountancy Data Network (FADN) is a system aimed for collecting and processing farms data on production and economic parameters. In that sense, it can be said that through a representative sample, this system continuously provides information on the natural and financial aspect of the farms business (Vasiljević, 2011). The system is based on a precisely defined methodology for all EU member states and enables comparison of the production and economic results between different countries. The FADN system, started in the EU in 1965, imposes an obligation to the Member States to collect a properly prescribed minimum of production and financial information, primarily intended for the creation of the CAP Common Agricultural Policy (Vasiljevic et al., 2012).

The process of establishing the Agricultural Accounting Data System in the Republic of Serbia started in 2011, with data collection from 40 farms (pilot survey). The application of a fully harmonized methodology for the selection of farms started in 2013 (452 farms), after calculating the Standard Output (SO) of the farms from the Agricultural Census 2012, there is successive annual increase in the FADN sample. The last cycle of data collection, for 2017, included 1,460 agricultural holdings, of which 1,404 were validated and included in the analysis.



Graph 1. The size of the FADN sample for the Serbia-North and Serbia-South regions (2014-2017)

Source: Authors based on data from FADN database

FADN is important for the analysis of data at the national level, macro indicators are used the most i.e. the information related to the business of farms enables the calculation of valid agroeconomic indicators (Bojcevski et al., 2016), and on the basis of their analysis, the adoption of adequate measures from different areas related to agro-sector (agrarian, customs, credit, monetary policy, etc.). In such circumstances, agricultural policy makers have at their disposal quantitative indicators on the terms and performance of the FARMS operations (Ivkov et al., 2013). At the farm level FADN is powerful toll in comparing results of farm with average results in same production line nationally and among EU countries (Bojcevski et al., 2015).

The basic indicators according to the FADN methodology are classified into different groups such as:

1) Production structure:
   - Total utilised agricultural area, share of rented agricultural land
   - Labour input (paid and unpaid labour)
   - Total livestock units (LU)
2) Productivity:
   - Crop yields (kg per ha)
   - Milk production per cow (kg per year)
   - Stocking density (LU per forage area)
   - Total crop output per UAA
   - Total livestock output per LU
3) Structure of total output:
   - Crop production, livestock production and other gainful activities
4) Structure of total input:

   Specific and overhead costs, external factors, depreciation
5) Subsidies:
   - Structure of subsidies
   - Subsidies (per UAA, LU)
   - Share of subsidies in FNVA
   - Share of subsidies in total output

In addition to the basic indicators, FADN data also enables the set of many derived indicators. Income analysis are among most important FADN tolls. Income categories can be grouped according to Type of farming (field crops, milk production, mixed farming ...), Economic size class, Total UAA (ha) etc (Bojcevski et al., 2016).

Most important income indicators are one or more indicators (i.e. NVA, NVA per AWU), or a percentage of performance (i.e. 25% most successful, 25% less successful).

The income indicators can be compared by years (Starting from 2000) and l location, region (Less favoured area - LFA), outside of the LFA areas, regions, counties, municipalities etc (Janković, 2016).

The Farm Accountancy data network are of special importance for developed South Eastern Europe countries which are developed under partially planned economy for many decades (Simonović et al., 2012; Sredojević et al., 2009).

Farmers improvement in book keeping as the enrolment in FADN system is proven to have positive effect on bank credits access (Popović et al., 2018).

Results and Discussion

According to Agricultural Census 2012 agricultural holdings in Republic of Serbia, reached a total standard output (SO) 3,750 million EUR, which is an average of 5,939 EUR per agricultural holding, or EUR 5,804 per one AWU (annual working unit). Number of farms per economic size classes and their share in the total standard output (SO) are shown in the following table 1[3].

Table 1. Number of farms per economic size classes and their share in the total standard output (SO)

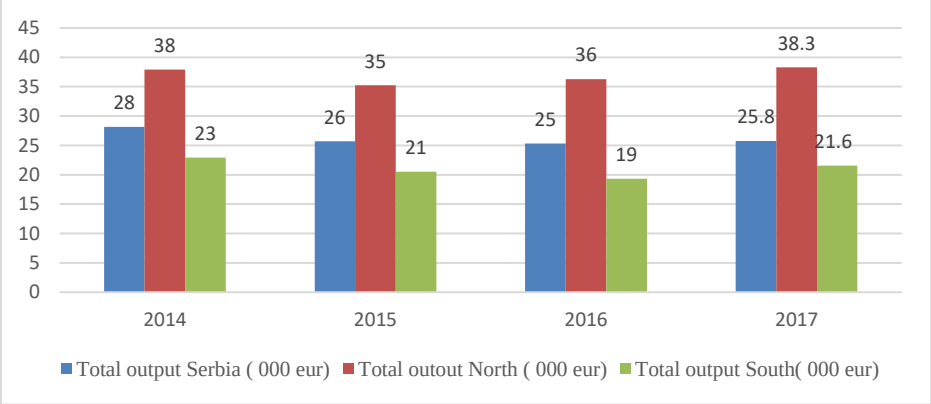
SO	Farms, number	Total SO, EUR	Share of size classes' SO in the total SO, %
100,000 or more	1,902	803,541,678	21.42
50,000-100,000	4,825	327,469,428	8.73
25,000-50,000	11,221	385,335,130	10.27
15,000-25,000	18,261	346,286,320	9.23
8,000-15,000	52,949	563,169,693	15.01
4,000-8,000	113,194	636,383,661	16.97
2,000-4,000	140,641	404,571,557	10,79
less than 2,000	288,559	284,033,429	7.57
Total	631,552	3,750,790,895	100.00

[3] Standard Output (SO) is the average monetary value of the agricultural output at the farm-gate price of each agricultural product (crop or livestock). The SO is calculated by Member States per hectare or per head of livestock, by using basic data for a reference period of five successive years. The SO of the holding is calculated as the sum of the SO of each agricultural product present in the holding multiplied by the holding's number of hectares or heads of livestock. The SO coefficients are expressed in euros and the economic size of the holding is measured as the total standard output of the holding expressed in euros.

Source: Agricultural Census 2012, Statistical Office of the Republic of Serbia

According to Agricultural Census 2012 there are 207,277 farms with at least one full time employee (working over 6 hours a day), i.e. 38.2% of the total number of farms in the Republic of Serbia provide for at least 1 full time employment. The highest average SO per holding by type of farming in 2012 was on holdings specialized in horticulture (almost EUR 11,000), and in field crops specialized (more than EUR 8,000).

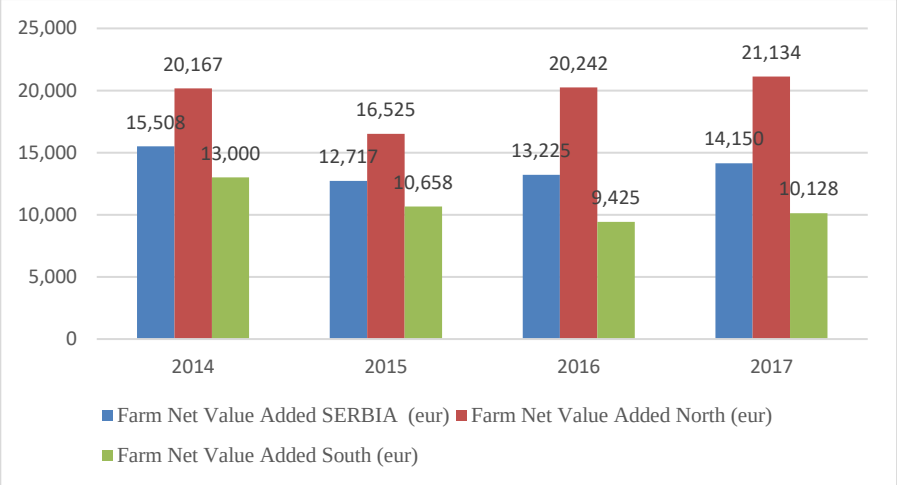
According to the FADN; data, the total value of production per farms presents about 2.8 million dinars or EUR 25. Data in 2017 do not show significant deviations from the previous years and amounts to RSD 2.9 million or EUR 25.8 thousand for the whole country. The results of the FADN survey show that there are major deviations between the North and South region, due to the different structure of the farm, and this significantly higher number of those belonging to larger economic categories in the North region. The higher total value of production per farm in this region is also affected by higher value of total yield in plant production, as well as higher total value of livestock products and the number of animals in livestock production.



Graph 1. Total output in Serbia, Serbia–North and Serbia-South (average per farm)

Source: Authors based on data from FADN database

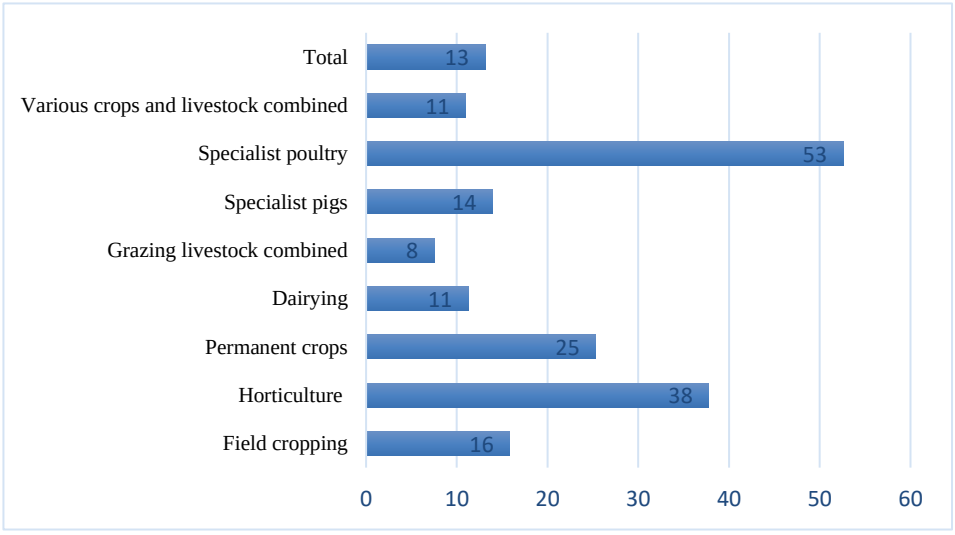
The Farm Net Value Added (FNVA) indicates the reimbursement for all the farm engaged factors of production (land, capital and workforce) in the holding, both in the ownership of the farm and outsourced. The average net added value of the household shows stagnation, so that in 2017 it amounted to 1.6 million dinars (EUR 14 thousand), and it is significantly higher in the region North Serbia 2.4 million dinars (EUR 21 thousand) in relation to the region South Serbia, 1.2 million dinars (EUR 10 thousand).



Graph 2. Farm Net Value Added in Serbia, Serbia-North and Serbia-South (average per farm)

Source: FADN database of MAFWM

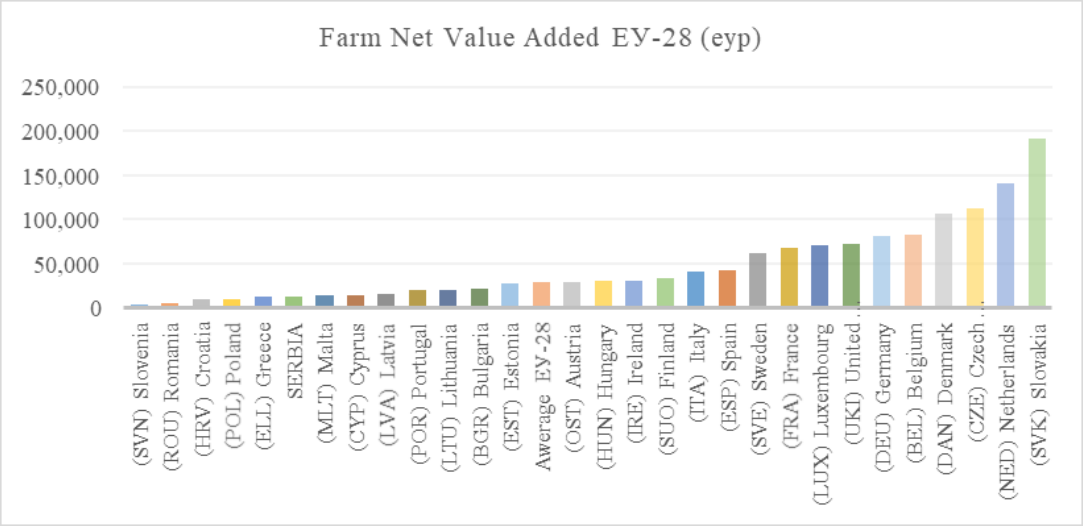
Comparison of the results according to the type of production points to the fact that in 2017, the households specialized in poultry and horticulture were the most successful, creating a net value added of 5.9 and 4.2 million dinars (EUR 53 thousand/38 thousand).



Graph 3. Farm Net Value Added in Serbia, (different type of farming) (000 EUR)

Source: FADN database of MAFWM

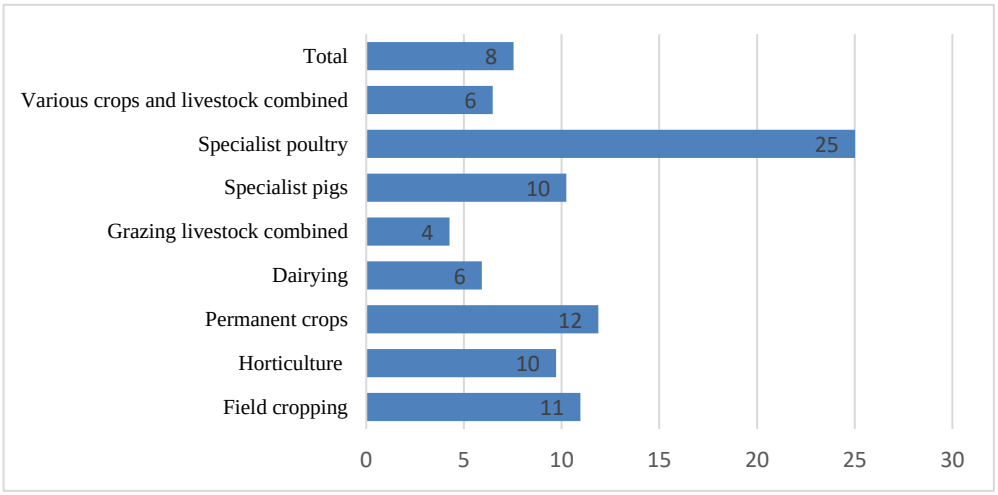
The Farm Net Value Added (FNVA) varies considerably in the EU member countries. The EU-28 average was around EUR 28,494. The main advantage of the average FNVA/farm lies in its relative simplicity but it fails to reveal the differences in farm size, type of farming or structural decreases in the labour force employed in agriculture. To overcome this, FNVA is usually expressed per AWU, which can be seen as a measure of partial labour productivity.



Graph 4. Farm Net Value Added in Serbia and EU-28

Source: FADN database of MAFWM (2017) and FADN EU database (2016)

Important FADN' income indicator is Farm Net Value Added per Annual Work Unit (FNVA/AWU) depends on the size of the farm, the type of agricultural business or the structural reduction of the labour force of the employed in agriculture.

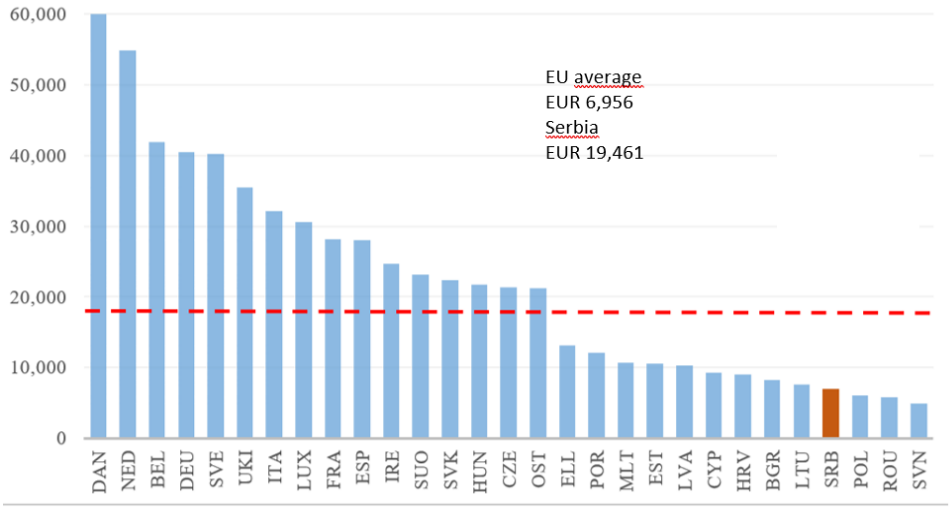


Graph 5. Farm Net Value Added per Annual Working Unit in Serbia (EUR)

Source: FADN database of MAFWM

FNVA/AWU varies significantly in EU Member States. The highest value was in Denmark, the Netherlands and Belgium, whose value is about EUR 60 thousand per farm, which indicates a lower labour cost per farm. On the other hand, the lower value of this indicator indicates lower

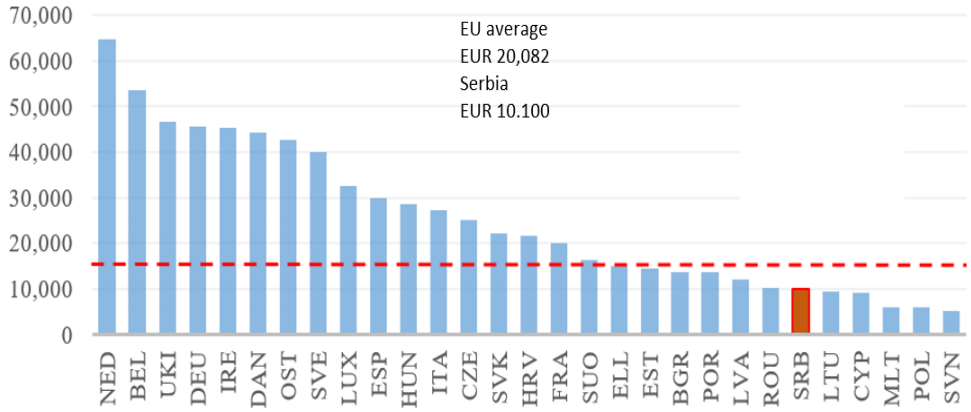
productivity. Serbia shows the extremely low value of this indicator, whose value is significantly below the EU-28 average, which amounted to about EUR 20 thousand. Farm Net Value Added per Annual Work Unit in Serbia amounted to about EUR 7,000 is among the lowest in Europe (see Graph 6).



Graph 6. FNVA/AWU in EU and Serbia (EUR)

Source: FADN database of MAFWM (2017) [4] and FADN EU database (2016)

Observed by different types of agricultural production, Serbia has significantly lower values of this indicator and is below the average of the countries of the European Union.

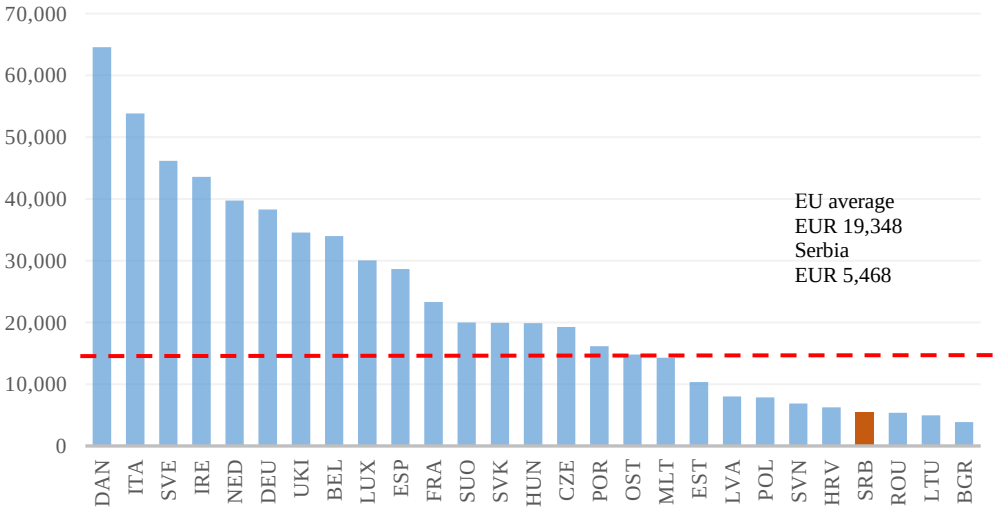


Graph 7. FNVA/AWU in field crop production EU and Serbia (EUR)

Source: FADN database of MAFWM (2017) and FADN EU database (2016)

[4] Considering the fact that the FADN system in the Republic of Serbia is in the phase of establishment, as a representative sample has not been fully established, the data shown must be observed in accordance with the existing sample. Therefore, the conclusions should be made with caution, taking into account possible uncertainties regarding the data presented.

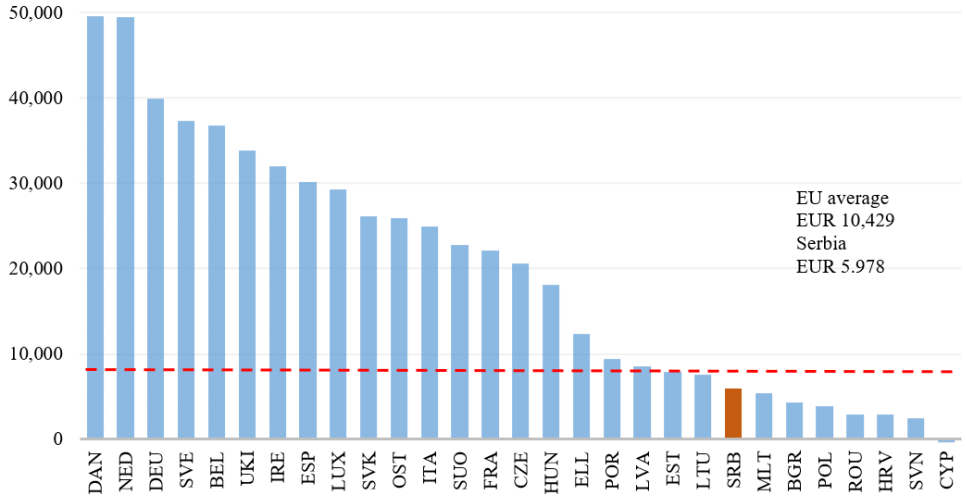
Farm Net Value Added per Annual Work Unit in crop production is according to Graph 7 among the lowest in Europe.



Graph 8. FNVA/AWU in dairy production - EU and Serbia (EUR)

Source: FADN database of MAFWM (2017) and FADN EU database (2016)

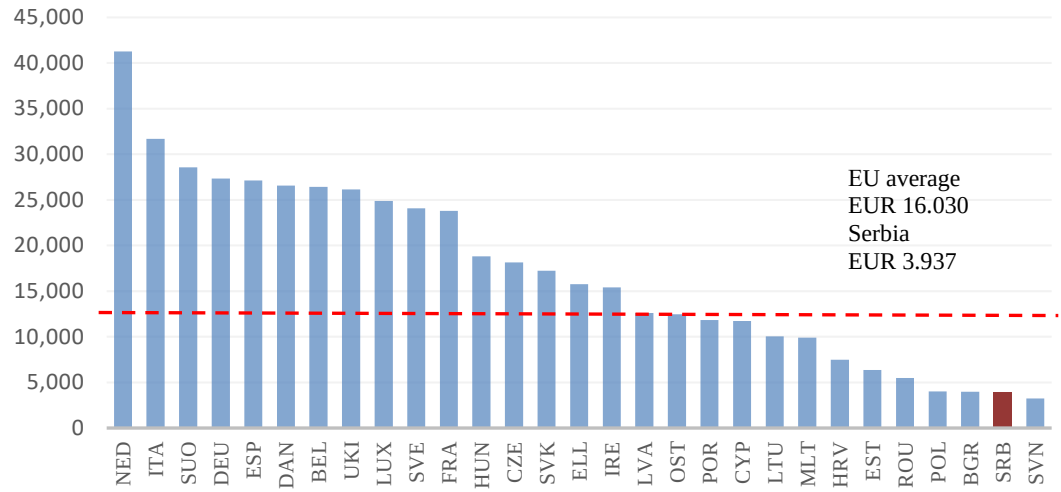
From Graph 8 can be observed that Serbia has very low FNVAAWU in dairy production compared to EU countries.



Graph 9. FNVA/AWU in mixed production - EU and Serbia (EUR)

Source: FADN database of MAFWM (2017) and FADN EU database (2016)

From Graph 9. can be observed that Serbia has very low FNVAAWU in mixed production compared to EU countries.



Graph 10. FNVAAWU in livestock and grazing - EU and Serbia (EUR)

Source: FADN database of MAFWM (2017) and FADN EU database (2016)

From Graph 10. can be observed that Serbia has very low FNVAAWU in mixed production compared to EU countries.

Conclusion

The results show the significant regional differences in FNVA per AWU in the EU-28 and Serbia. Based on this indicator, the farms with the highest income per working unit were mainly located in Denmark and Nederland. In these regions, there is a high percentage of highly intensive granivore production, horticulture and milk farms. On the other hand, Serbia have very low farm income (below EUR 10 000 per year), lower than average in all EU countries.

Furthermore, the FADN' Farm Net Value Added is a proved as reliable and highly useful indicator of farm income in EU and Serbia. At the macro level agricultural policy makers can use this indicator in analysing agricultural sector, while farmers can use this indictor to compare farm income with average income within the same line of production.

Serbian FADN sample is still not representatives and recommendation is going in direction to enlarge sample and achieve representativeness and reliability of all FADN' indicators. Further research could be directed toward creation of new FADN' income indicators as all countries are allowed to introduce additional national indicators. Furthermore, farmers education on technique on use of income indicators will be of highly importance in farm management improvements in Serbia.

References

Bojcevski M., Kovacevic V. & Subic J. (2015). *Importance of a farm accountancy data networks (FADN) for Agricultural sector in Serbia*. 2nd international symposium for agriculture and food. ISAF 2015. Organized by Faculty of Agricultural Sciences and Food - Skopje in co-organization with Institute of Animal Sciences, University Ss. "Cyril and Methodius" in Skopje. October, 2015. Ohrid, Republic of Macedonia.

Bojcevski M., Kovacevic V. & Subic J. (2016). Roll of a farm accountancy data networks (FADN) in agricultural sector in Serbia. *Ekonomika*, Niš. pp. 69-79, ISSN 0350-137X.

Bojcevski M., Kovacevic V., Ivkov I. & Veselinovic G. (2016). *Standard results of FADN research in Serbia*. 10th AAEM International Conference "Policy and Economics for Sustainable Agricultural and Rural Development". May 2016, Ohrid, Republic of Macedonia.

Commission Implementing Regulation (EU) 2015/220 of 3 February 2015 laying down rules for the application of Council Regulation (EC) No 1217/2009 setting up a network for the collection of accountancy data on the incomes and business operation of agricultural holdings in the European Union, OJ L 46, 19.2.2015, 1–106

Commission Implementing Regulation (EU) 2015/2323 of 11 December 2015 amending Implementing Regulation (EU) 2015/220 laying down rules for the application of Council Regulation (EC) No 1217/2009, OJ L 328, 12.12.2015, 97–100

Council Regulation (EC) No 1217/2009 of 30 November 2009 setting up a network for the collection of accountancy data on the incomes and business operation of agricultural holdings in the European Community, OJ L 328, 15.12.2009, 27–38

Directorate General for Agriculture and Rural Development (DG AGRI). *EU FADN database* - Retrieved from: http://ec.europa.eu/agriculture/rica/database/database_en.cfm.

EU Commission. web page - FADN unit DGAGRI - http://ec.europa.eu/agriculture/ricaprod/ (accessed: 08.08.2015)

European Union. *Official FADN web*. Retrieved from: http://ec.europa.eu/agriculture/rica/legalbasis_en.cfm accessed on: 22. March 2016.

FADN Serbia: Retrieved from: http://www.fadn.rs/ 05, April 2016.

Ivkov I., Vasiljevic Z. & Ghelfi R. (2013). *Establishment of the Serbian FADN institutional framework*. Book of proceedings, 50th Anniversary Seminar, Agriculture and Rural Development - Challenges of Transition and Integration Processes. pp. 336-354.

Janković Irena (2016). *Analiza izabranih ekonomskih indikatora razvoja poljoprivrede u Srbiji: primer proizvodnje i distribucije maline*. Monografija Stanje i perspektive agroprivrede i sela u Srbiji. Beograd. Univerzitet u Beogradu, Ekonomski fakultet, Centar za izdavačku delatnost, 161-176.

Jeločnik, M., Bekić, B. & Subić, J. (2012). *Aspects of development of Serbian agriculture in the context of the global economic crisis*. Scientific Papers Series „Management, Economic Engineering in Agriculture and Rural Development". Vol. 12, Issue 1/2012. University of Agricultural Sciences and Veterinary Medicine Bucharest, Romania.

Popović S., Janković I. & Stojanović, Ž. (2018). The Importance of Bank Credits for Agricultural Financing in Serbia. *Economics of Agriculture*, Vol. 65, No.1, 65-80.

Regulation (EU) No 1318/2013 of the European Parliament and of the Council of 22 October 2013 amending Council Regulation (EC) No 1217/2009 setting up a network for the collection of accountancy data on the incomes and business operation of agricultural holdings in the European Community, OJ L 340, 17.12.2013, 1–6.

Simonović, Z., Jeločnik, M. & Vasić, Z. (2012). Economic position of Serbian agriculture in the transition period. *Economics of Agriculture*, 59(3), pp. 535-545.

Sredojević, Z., Jeločnik, M. & Beatović, S. (2009). Knjigovodstvena evidencija kao mogućnost unapređenja porodičnog gazdinstva u periodu tranzicije. *Ekonomika*. Vol. 55, br. 3-4, str. 110-119.

Statistical Office of the Republic of Serbia. *Agricultural Census 2012*.

Vasiljevic Z., Zaric V. & Ivkov I. (2012). *Recording of accountancy data at the family farms in Serbia*. Third International Scientific Symposium "Agrosym Jahorina 2012". November 15-17, 2012. Jahorina, Faculty of Agriculture, . pp. 599-604.

Vasiljević Zorica (2011). Uspostavljanje mreže računovodstvenih podataka na porodičnim poljoprivrednim gazdinstvima u Srbiji. *Izazovi evropskih integracija*, Tema broja "Poljoprivreda Srbije u procesu evropskih integracija", 2012/19, 27-40.

Original scientific paper

Comparative advantages and intra-industry trade for meat sector in Bosnia and Herzegovina's trade

Vesna Mrdalj [1], Nataša Tomić [1], Nemanja Jalić [1], Aleksandar Ostojić[1], Željko Vaško[1]

[1]University of Banja Luka Faculty of Agriculture, Bulevar vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosnia and Herzegovina

Corresponding author: Vesna Mrdalj, vesna.mrdalj@agro.unibl.org

Abstract

The aim of paper is analysing the foreign trade of three types of meat; poultry, pork and beef, as well as identification of comparative advantages and the level of specialization in intra-industry trade of these products between Bosnia and Herzegovina and the rest of world. The analyses are referred for a time period between 2014 and 2017. Indicators used in the analysis are: RCA as an index of comparative advantages; GL_i which shows the level of specialization in intra-industry trade and RUV index for the analysis of horizontal and vertical specialization in intra-industry trade. All three types of meat recorded in the analysed period negative values of RCA index. Poultry and beef meat had higher level of specialization in intra-industry trade in compare to pork with very low values of GL_i. RUV indicator shows prevalent vertical specialization in intra-industry trade of meat sector.

Key words: meat, Bosnia and Herzegovina, comparative advantages, intra-industry trade

Introduction

In past two decades, agri-food sector of Bosnia and Herzegovina is faced with many changes during the transformation into the market economy. One of the components of transition process in Bosnia and Herzegovina was trade liberalization, which implied incorporation of international trade rules in domestic foreign trade policy. The negotiations with WTO started in 1999, were a precondition for establishing of several important trade agreements, which generally led to the trade liberalisation in agri-food products. Since 2000 Bosnia and

Herzegovina signed 32 bilateral free trade agreements with Western Balkan countries, which are in 2006 replaced by multilateral trade agreement CEFTA. Considering that one of strategic goals of Bosnia and Herzegovina is membership in European Union, in 2008 country signed also the Stabilisation and Association agreement (SAA), and simultaneous an Interim Agreement on Trade and Trade Related Matters with EU. In such trade environment and changes of agri-food sector during the transition process; changes in ownership structure of capital, low technical and technological level in development of agricultural holdings, low level of budgetary support to agriculture and rural development ect. agri-food sector of Bosnia and Herzegovina hardly ensures competitiveness on international markets.

One of the important sectors in the structure of agricultural production of Bosnia and Herzegovina is livestock sector. In according to Ostojić and Vaško (2019): "Bosnia and Herzegovina has favourable conditions for the development of livestock production, from the aspect of ensuring the volume and quality of animal feed. However, the current situation regarding the utilization of land capacities for the production of animal feed is unfavourable. The low technological level of production, high production costs, disorganized market and purchase of animal products, low level of livestock production subsidies in relation to neighbouring countries, liberalization of market, depopulation of rural areas and migration of rural population as well as leaving livestock production have further affected the stagnation or reduction of meat production and low level of satisfaction of the population own needs in animal products" (page 51). This situation led Bosnia and Herzegovina to the orientation of import in all types of meat, including the beef, pork and poultry. The same authors (2019) estimated the import dependency ratio for beef, pork and poultry in period from 2014 to 2017 and stated that Bosnia and Herzegovina had high level of dependence on imports of beef with coefficient ranged from 55 to 65%; in pork import dependency ratio accounted an average 24% and in poultry is recorded the lowest import dependency ratio with average 19%. Furthermore, imbalance between supply and demand on meat market in Bosnia and Herzegovina also caused the higher import-orientation of country, except poultry. Estimation of self-sufficiency ratio for all basic types' meat shows that Bosnia and Herzegovina in period from 2014 to 2017 had a very low level of self-sufficiency in beef (ranged between 38-59%). Self-sufficiency ratio in pork was from 74 to 78 % and in the poultry the highest from 86% to almost 92% (Ostojić and Vaško, 2019).

In order to asses the competitiveness of three type's meat; beef, pork and poultry on international markets during the transformation in the market economy, in this paper are analysed comparative advantages and the level of specialization in intra-industry trade. Intra-

industry trade is defined as simultaneous export and import of commodities of same industry (Vollarth, 1991). There are two components of intra-industry trade; horizontal (HIIT), which implies the export and import of approximately same quality products and vertical (VIIT), whereby is trade between products of different quality. The aim of this paper is determination of structure of intra–industry trade specialization in three type's meat of Bosnia and Herzegovina in period 2014-2017, i.e. wich component of intra–industry trade is dominant.

Material and Methods

The research was conducted based on data referred to trade in meat sector between Bosnia and Herzegovina and World for period from 2014 to 2017. Data were collected from Indirect Taxation Authority of Bosnia and Herzegovina for tariffs group: beef (beef carcasses and halves, fresh 0201 10 00 00 - 0201 30 00 10; frozen beef 0202 10 00 00 - 0202 20 90 20; beef with bones, frozen 0202 30 10 00 – 0202 30 90 20; beef without bones, frozen 0202 30 10 10 – 0202 30 90 20; slaughterhouse products 0206 10 10 00 – 0206 49 00 00; processed beef 0210 20 10 00 – 0210 20 90 00); pork (pork, fresh, chilled or frozen 0203 11 10 00 – 0203 29 90 00; slaughterhouse products from pigs 0206 30 00 00 – 0206 80 10 00; pork fat 0209 10 11 00 – 0209 90 00 00; other processed pork meat 0210 11 11 00 – 0210 19 90 00) and poultry (poultry, fresh and chilled 0207 11 10 00 – 0207 14 10 00; poultry, frozen 0207 14 10 00 – 0207 14 99 00; meat of turkey 0207 24 10 00 – 0207 207 99 00; processed chicken 0210 99 85 00 – 0210 99 90 00). To determine comparative advantages and the level of specialization in intra-industry trade in beef, pork and poultry meat between Bosnia and Herzegovina and World, Balassa (RCA) and Grubel-Lloyd (GL) indexes were calculated. The Revealed comparative advantages are calculated by following version from Balassa (1965):

$$\text{RCA} = \ln\left[\frac{X_i}{M_i}\right] \times \left(\frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{n} M_i}\right) \times 100$$

where *X* and *M* represents values of export and import respectively; *i* is a single product or product groups. If RCA indicator has a positive value, then a country has a comparative advantage in certain product or product groups. Further, the negative value of RCA indicator shows lack of comparative advantages for certain product or product groups. RCA indicator is calculated for all three type of meat: poultry, pork and beef. For the analysis of level of intra – industry trade specialization is used Grubel–Lloyd index. GLi is originally developed by Grubel and Lloyd (1975), and in this paper is calculated for product groups in according to following formula:

$$GL_i = \frac{\sum_{i=1}^{n}(x_i + M_i) - \sum_{i=1}^{n}|x_I - M_i|}{\sum_{i=1}^{n}(x_i + M_i)} \times 100$$

where GL_i is Grubel–Lloyd index for product groups *i*; *X* and *M* represents values of export and import. The value of this indicator may vary from 0 to 1. The closer it is to 1, the higher is the degree of intra-industry specialization. The lower value of GL_i, precisely closer 0, and then the level of specialization in inter-industry trade is higher. Relative Unit Value (RUV) indicator is used for analysis of horizontal and vertical intra-industry trade. Originally was developed by Abd-el-Rahman (1991). The indicator is based on the ratio of unit value of exports and imports:

$$1 - \alpha \leq \frac{UVX_i}{UVM_i} \leq 1 + \alpha$$

where UVX_i is unit value of export for product *i* or product group. It is calculated as the value of export divided by the export quantity. UVM_i stands for unit value of import, and calculated as the value of import divided by the import quantity. Parameter α is coefficient of dispersion. In researches this coefficient is assumed to be *e*qual 0.15 (Abd-el Rahman, 1991; Greenway et al.,1995; Aturpane et al., 1999; Blanes et al., 2000; Algieri, 2004; Reganati and Pittiglio, 2005; Buturac, 2006; Mrdalj et al., 2017).

If the Relative Unit Value is within the interval (0.85; 1.15) intra-industry trade is horizontal; conversely if it is outside of this interval it is vertical. If the RUV is less than 0.85, then dominates the import of high value added (or export of low value added). If this indicator is greater than 1.15 it shows export of high value added. Based on above mentioned vertical intra–industry trade is assumed to have two components, high quality (HQVIIT) and low quality (LQVIIT). A high share of LQVIIT means that a country is specializing in relatively low-priced export goods in the vertically differentiated sectors. Therefore, if the Relative Unit Value of a good is below the limit of 0.85, it is considered to be a "low quality export". On the other side, a high share of HQVIIT implies that VIIT takes the form of high-valued exports, i.e. if the RUV indicator is over the limit 1.15, it is considered a "high quality export" (Buturac and Rajh, 2006).

Results and Discussion

This section of paper is divided in two parts. The first part represents the data of total trade of agri-food sector, as well as in trade in poultry, pork and beef meat between Bosnia and Herzegovina and Rest on World in period of time 2014-2017. The second part of this section is referred to empirical results obtained by calculation of Balassa index, Grubel- Lloyd and

RUV index. In period 2014-2017 Bosnia and Herzegovina recorded constantly an unfavorable balance trade in agro- food products, as well as in all three types of meat (Table 1).

Table 1. Trade of agro-food industry and meat sector between Bosnia and Herzegovina and World (in mill. BAM)[5]

Agro-food industry BH (CT 01-24)	2014	2015	2016	2017
Import	2.752	2.891	2.950	3.125
Export	649	818	934	1.009
Total	3.401	3.709	3.884	4.134
Deficit	-2.103	-2.073	-2.016	-2.116
Coverage of import by export	**23.58**	**28.29**	**31.66**	**32.29**
Beef				
Import	169.40	169.40	171.26	157.23
Export	7.57	87.73	83.05	49.56
Total	176.97	257.12	224.31	206.79
Deficit	-161.82	-81.67	-118.21	-107.67
Coverage of import by export	**4.47**	**51.79**	**30.98**	**31.52**
Structure %				
Import	6.16	5.86	5.81	5.03
Export	1.17	10.72	5.68	4.91
Total	5.20	6.93	5.77	5.01
Deficit	7.69	3.94	5.86	5.09
Pork				
Import	60.74	61.80	65.51	65.48
Export	2.02	0.54	1.60	1.86
Total	62.76	62.35	67.11	67.34
Deficit	-58.73	-61.26	-63.91	-63.62
Coverage of import by export	**3.32**	**0.88**	**2.45**	**2.84**
Structure %				
Import	2.21	2.14	2.22	2.10
Export	0.31	0.07	0.17	0.18
Total	1.85	1.68	1.73	1.63
Deficit	2.79	2.96	3.17	3.01
Poultry				
Import	26.20	23.64	20.23	18.57
Export	10.54	11.47	11.57	10.83
Total	36.74	35.10	31.80	29.40
Deficit	-15.65	-12.17	-8.66	-7.74
Coverage of import by export	**40.24**	**48.52**	**57.19**	**58.33**
Structure %				
Import	0.95	0.82	0.69	0.59
Export	1.62	1.40	1.24	1.07
Total	1.08	0.95	0.82	0.71
Deficit	0.74	0.59	0.43	0.37

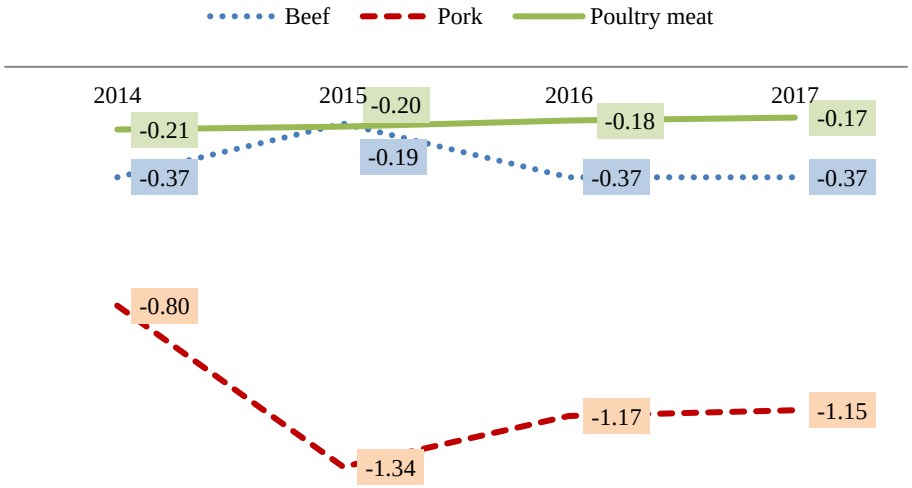
Source: Indirect Taxation Authority of Bosnia and Herzegovina; calculation of structure by authors.

[5] International code BAM.

Import value of Bosnia and Herzegovina's agri-food sector ranged between 2.752 and 3.125 billion BiH convertible marks and exports from 649 million BAM to 1.009 billion BAM. Covering of import by export of agro-food sector has increased from 23.58% to 32.29%. In terms of value of beef import, the year 2016 is emphasized as the importing year of 171.26 million BAM, while the export increased in 2015 with value of 87.73 million BAM. In 2015 was the highest covering rate of 51.79% in trade with beef. Regarding the share of beef in total value of agro-food trade, is ranged between 5.01% (2017) and 6.93% (2015). In the values of imported beef, tariffs group of beef carcasses and halves, fresh (135.99 – 151.89 million BAM) and beef without bones, frozen (11.32 – 14.44 million BAM), are dominate. In the value of exported beef also prevail tariff group beef carcasses and halves fresh with amount ranged from 6.49 to 66.59 million BAM. Due to the agreed trade arrangement between Bosnia and Herzegovina and Turkey, export of beef is increased, during the period time from 2015 to 2016. Import of pork was on the level 60.74 – 65.51 million BAM. Very low level of export values in pork Bosnia and Herzegovina recorded in observed period, i.e. between 0.54 – 2.02 million BAM. The value of imported pork is dominated by tariff group fresh, chilled or frozen pork with amount between 55.18 – 58.03 million BAM. In the value of exported pork dominated the tariff group of other processed pork meat with values between 0.54 - 1.84 million BAM. Regarding the poultry, in observed period import was higher than export. Deficit over the four years has been decreased for 55% (2016) and 49% (2017) in compare to year 2014. Coverage of import by export has increased from 40.24% to 58.33%. In the structure of imported poultry, the most dominated tariff groups were: poultry fresh and chilled (7.28 – 10.68 million BAM), poultry frozen (5.05-9.50 million BAM) and turkey meat (5.99-6.82 million BAM). In the value of exported poultry dominated the same tariff groups of poultry meat: meat of poultry fresh and chilled (5.01- 7.47 million BAM) and meat of poultry frozen (4.07- 5.76 million BAM). Generally, in the structure of Bosnia and Herzegovina's total export and import in agro-food products, the highest share recorded by beef, while the lowest share in total export of agro-food sector had pork.

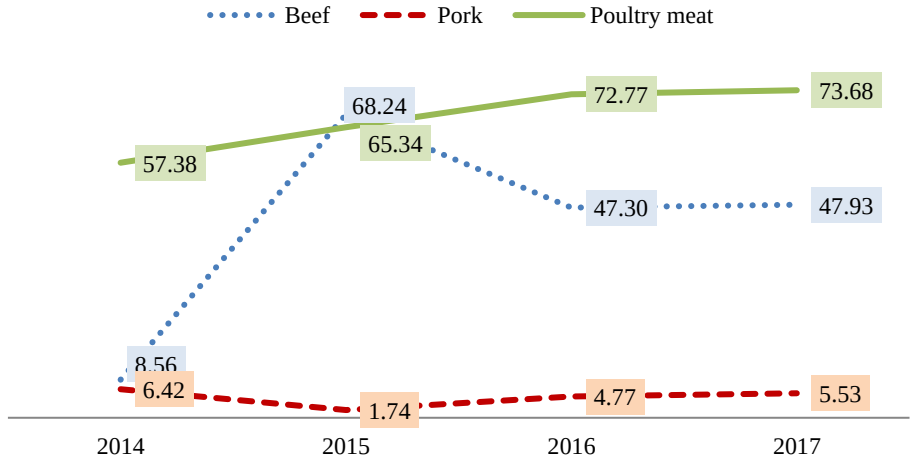
In order to define the international position of Bosnia and Herzegovina in trade with poultry pork and beef, are made analysis of three indices; RUV, GL_i and RUV (Graphs 1-3). RCA index indicated that Bosnia and Herzegovina had lack of comparative advantages in observed group of products (Graph 1). The most pronounced lack of comparative advantages in analysed period was recorded in international trade of pork. In 2015 the value of RCA index was -1.34. The RCA index for beef has also negative values; in the beginning of observed period RCA value for beef was – 0.37, while in period of time 2015-2017 this product had less pronounced

lack of comparative advantages (RCA_{2015} =-0.19; RCA_{2016} =-0.37; RCA_{2017} = -0.37). In relation to international market, Bosnia and Herzegovina had a lack of comparative advantages in trade with poultry, with values of RCA_{2014} =- 0.21; RCA_{2015}=-0.20; RCA_{2016}= -0.18 and RCA_{2017}=-0.18. Based on it and comparing with other two types of meat, poultry had the least pronounced lack of comparative advantages.



Graph 1. RCA index for beef, pork and poultry meat between Bosnia and Herzegovina and World in period 2014 -2017

Value of GL index showed that Bosnia and Herzegovina recorded high level of this indicator in poultry and beef during the analysed period (Graph 2).



Graph 2. GL index for beef, pork and poultry meat between Bosnia and Herzegovina and World in period 2014 -2017

GL index for poultry recorded constant growth in observed period. The highest value of GL_i was in 2017 (73.68%). Except 2014 where trade in beef was more inter – industry (GLi_{2014}= 8.56%), in last three years of observed period they are visible higher values of the level of specialization in intra –industry trade (GLi_{2015}=65.34%; GLi_{2016}=47.30%; GLi_{2017}=48.66%). Values of GL for beef (2015-2017) and poultry indicate structural changes in these two sectors. RUV index determines the ratio of unit value of exports and imports. Based on interpretations of RUV index, Bosnia and Herzegovina in the trade of all three types' meat had vertical specialization in intra-industry trade with component of dominated HQVIIT (high quality vertical intra-industry trade). Considering the types of meat, Bosnia and Herzegovina was specializing in high priced (valued) export of poultry, i.e. fresh and chilled poultry (RUV_{2014}=1.88; RUV_{2015}=1.54; RUV_{2017}=1.29), as well as frozen poultry (RUV_{2015}=2.27; RUV_{2016}=2.01; RUV_{2017}=1.64). High priced export is also recorded by beef; beef carcasses and halves, fresh during the observed period, with the highest values of RUV in 2017 (2.13); beef with bones, frozen with RUV_{2014}=23.36 and slaughterhouse products from beef RUV_{2017}=1.59.

Table 2. RUV index for beef, pork and poultry products

	RUV indices			
	RUV <0.85			
Products/ years	2014	2015	2016	2017
Processed beef	0.56	0.75	:	:
Processed pork	:	:	0.68	0.23
Meat of poultry, fresh and chilled	:	:	0.16	:
Meat of turkey	:	:	0.48	:
Processed chicken	:	:	:	0.73
	RUV 0.85; 1.15			
Processed beef	:	:	0.90	1.05
Pork, fresh, chilled or frozen	0.96	:	.	:
Slaughter products from pigs	:	:	:	0.91
Meat of poultry, frozen	1.14	:	:	:
	RUV >1.15			
Beef carcasses and halves, fresh	1.71	1.97	1.80	2.13
Beef with bones, frozen	23.66	1.92	:	:
Slaughter products from beef	:	:	:	1.59
Meat of poultry, fresh and chilled	1.88	1.54	:	1.29
Meat of poultry, frozen	:	2.27	2.01	1.64

Source: authors' calculation.

Horizontal intra-industry trade ("trade in commodities of same quality") is recorded by processed beef meat (RUV_{2016}=0.90; RUV_{2017}=1.05) and pork products (RUV_{2014}=0.96;

RUV_{2017}=0.91).Vertical intra-industry trade is took the form of low priced export or "low quality export" mostly by processed products of beef, pork and chicken.

Conclusion

In period 2014-2017, Bosnia and Herzegovina recorded an unfavourable trade balance in agri-food as well as in meat sector. Trade liberalization based on conclusion of free trade agreements between Bosnia and Herzegovina and other countries, influenced on significant openness of domestic market and import. Except poultry, Bosnia and Herzegovina in analysed period recorded very low level self-sufficiency ratio in beef and pork. In terms of competitiveness in trade of beef, pork and poultry on international markets, Bosnia and Herzegovina based on calculations of RCA, GL and RUV indices, has lack of comparative advantages (most pronounced in pork and less in poultry); has high level of specialization in intra –industry trade of poultry and beef, while pork recorded low level of economic integration on international markets. GL values for poultry and beef during the observed period reflects the structural changes in these two sectors. RUV indicator shows prevalent vertical specialization in intra-industry trade of meat, i.e. mostly high priced export in beef and poultry products. Despite favourable conditions for development of livestock productions, for improving of better economic integration and competitiveness of meat sector in international markets; beef, pork and poultry in Bosnia and Herzegovina, it is necessary stronger support to on – farm investments, agri- food restructuring (food processing industry, marketing, promotion), and to public services related to agriculture (quality and safety assurance system).

References

Abd–el–Rahman, K. (1991). Firm's Competitive and National Comparative Advantages as Joint Determinants of Trade Composition. *Weltwirtschaftliches Archiv*, 127 (1), 83-97.

Algieri, B. (2004). *Trade Specialization Patterns: The Case of Russia*. BOFIT Discussion Papers, No.19/2004 (Helsinki: BOFIT Institute).

Ostojić, A. & Vaško, Ž. (2019). Projections of selfsufficency of Bosnia and Herzegovina in basic types of meat. Sustainable Agriculture and Rural Development in terms of the Republic of Serbia, Strategic goals realization within the Danube Region – sustainability

and multifunctionality, Thematic proceedings, Institute of Agricultural Economics Belgrade, Serbia, 50-67.

Aturupane, C., Djankov, S. & Hoekman, B. (1999). Determinants of Intra-Industry Trade Between East and West Europe. *Weltwirtschaftliches Archiv*, 135(1), 60-81.

Balassa, B. (1965). Trade Liberalization and Revealed Comparative Advantage. *The Manchester School of Economic and Social Studies*, Vol. 32, 99-123.

Blanes, J.V. & Carmela, M. (2000). The Nature and Causes of Intra-Industry Trade: Back to the Comparative Advantage Explanation? The Case of Spain. *Weltwirtschaftliches Archiv*, 136(3), 423-441.

Buturac, G., Rajh, E. (2006). Vertical Specialization and Intra–industry trade: The Case of Croatia. *Economic Research*, 19 (1), 37-49.

Greenaway, D., Hine, R.C. & Milner, C.R. (1995). Vertical and Horizontal Intra-Industry Trade: A Cross-Industry Analysis for the United Kingdom. *Economic Journal*, 105, 1505-1518.

Grubel, H.G. & Lloyd, P.J (1975). *Intra –industry trade: the theory and measurement of international trade in differentiated products*. Wiley, London and New York.

Reganati, F., Pittiglio, R. (2005). *Vertical Intra–Industry Trade: Patterns and Determinants in the Italian Case.* Quaderni DSEMS 06-2005 (Foggia: Department of Economics, Mathematics and Statistics, University of Foggia).

Mrdalj, V., Vaško, Ž., Ostojić, A. & Brković, D. (2017). Structure and Determinants of Intra–Industry Trade in Agro–Food Sector of Bosnia and Herzegovina, European Center for Science Education and Research, ICSS XII 2017, 12th International Conference on Social Sciences, 19-20 May, 2017, Amsterdam, *European Journal of Interdisciplinary Studies*, Volume 8, Nr. 1, 154-163.

Vollrath, T.L, (1991). A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage. *Weltwirtschafliches Archiv*, Volume 127 (2), 265-280.

Komparativne prednosti i intra–industrijska razmjena za sektor mesa u trgovini Bosne i Hercegovine

Vesna Mrdalj[1], Nataša Tomić[1], Nemanja Jalić[1], Aleksandar Ostojić[1], Željko Vaško[1]

[1] Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Bulevar vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosna i Hercegovina

Autor za korespondenciju: Vesna Mrdalj, vesna.mrdalj@agro.unibl.org

Sažetak

Cilj rada predstavlja analiza spoljnotrgovinske razmjene tri vrste mesa; pilećeg, svinjskog i goveđeg, kao i utvrđivanje komparativnih prednosti, te nivoa specijalizacije u intra–industrijskoj razmjeni ovih proizvoda između Bosne i Hercegovine i ostatka svijeta. Analiza se odnosila na period 2014-2017. godina. Indikatori korišteni u analizi su: RCA kao indeks comparativnih prednosti; GLi koji pokazuje nivo specijalizacije u intra–industrijskoj razmjeni i RUV indeks za analizu horizontalne i vertikalne specijalizacije u intra–industrijskoj razmjeni. Sve tri vrste mesa u analiziranom periodu bilježile negativne vrijednosti RCA indeksa. Pileće i goveđe meso su imale visok nivo specijalizacije u intra–industrijskoj razmjeni u odnosu na svinjsko sa veoma niskom vrijednosti GL_i. RUV indikator pokazuje dominaciju vertikalne specijalizacije u intra–industrijskoj razmjeni mesa.

Ključne riječi: meso, Bosna i Hercegovina, komparativne prednosti, intra–industrijska razmjena

Original scientific paper

Local background values of the lead in the soils of the Banja Luka area

Mihajlo Marković[1], Dijana Mihajlović[1], Svetlana Antić-Mladenović[2], Milan Šipka[1]

[1] *University of Banja Luka, Faculty of Agriculture, Banja Luka, Bosnia and Herzegovina*

[2] *University of Belgrade, Faculty of Agriculture, Belgrade, Serbia*

Corresponding author: Dijana Mihajlović, dijana.mihajlovic@agro.unibl.org

Abstract

The aim of this paper was determination of the total contents and local background values of the lead (Pb) in the soils of the Banja Luka area. The research was carried out by analyzing the 200 samples of the soils, taken from the top soil-layer (0-25 cm). Total contents of the Pb were determined by atomic absorption spectrophotometry after acid digestion (HNO_3+HCl). Background values for lead have been evaluated by several methods: classical [Mean ± 2σ], [Median ± 2MAD], iterative 2σ method, box plot-upper whiskers and graphical methods (box plot and cumulative probability graphs). Total Pb in all examined samples were lower (range: 15,41-98,06 mg Pb kg^{-1}) than maximal allowed content for unpolluted soils (100 mg Pb kg^{-1}). The average background value in the investigated soils was 44,34 mg Pb kg^{-1}. The results imply to geochemical origin of Pb in the investigated soils, with some anthropogenic loads.

Key words: heavy metals, environment, pollution, risk

Introduction

Knowledge of the background concentrations is basic point in considering the human impact on geochemical parameters of soils. It enables quantification of the natural amounts of the elements as well as those resulting from various anthropogenic activities (Galuszka and Migaszewski, 2011). Data about the local background values are important for proper risk assessment in the environment (Reimann and Garret, 2005). Thanks to the background values it is possible to calculate: enrichment factor (EF), geoaccumulation index (Igeo), pollution

index (PI) and other similar criteria used for determination of the soil contamination level. This is especially important in the case of toxic elements such as lead (Pb).

Humans used lead since ancient times. Even today, Pb is one of the most widely used metals (Hooda, 2010). On the other side, it has no known biological role. Thanks to the results of numerous researches in the second half of the 20th century, the awareness about the lead toxicity for living beings has increased significantly (Newton, 2010). This element can cause mental and physical problems to the young children, as well as and different health disorders to the adults (Prasad, 2008). In addition, lead compounds were categorized as potentially cancerous (IARC, 1990). Considering those facts, lead and its compounds were replaced, in industry and manufacture, with other non-toxic elements and compounds whenever that was possible. Nevertheless, there are many products and applications where is impossible to find satisfactory substitute (Newton, 2010). Because of that the precise data about the current contents and background levels of the lead in the environment are particularly important.

There are many statistical methods used for estimation of the background values of elements in the soils (Matschullat et al., 2000). Some of them have usually been used like classical method [Mean ± 2σ] and [Median ± 2MAD], where MAD is median of the absolute deviations from medial of all data (Reimann and Garret, 2005). Thanks to both methods it is possible to find out the interval of background values, but in the environmental analysis, as in this paper, only the upper values in this range are considered. International Organization for Standardization (ISO, 2005) proposed determination of backgrounds in the soils based on the Tukey inner fence (TIF) or upper whisker in boxplot (Tukey, 1977). In order to avoid the influence of the extreme values in the classical calculation [Mean ± 2σ], the iterative 2σ-approximation was established (Erhardt, 1998). Determination of the background levels includes also numerous graphical methods (box plot, cumulative probability plot, histogram and other), which allow a better view into data structure (Matschullat et al., 2000).

It is important to stess significant difference between background values obtained with various methods (Matschullat et al., 2000; Reimann and Garret, 2005; Mrvić et al., 2011;). Because of that, a lot of authors apply simultaneously several methods for the same data set (Zglobicki et al., 2011; Rodrigues et al., 2013; Mrvić et al., 2014; Reimann and Caritat, 2017) and some of them finally calculate the background values as the average of the values obtained by different techniques (Zglobicki et al., 2011; Rodrigues et al., 2013). In order to avoid the mistakes caused with variety of soil types and geological substrates it is recommended to determine the background values on a local level, in a smaller areas (Diez et al., 2009). Considering all before mentioned and lack of the systematic environmental studies and data about local background

values for the toxic and potentially toxic elements in the Banjaluka area the main objectives of this work were: 1. determination of total lead contents and 2. assessment of the local background values for this element in the soils.

Material and Methods

This research was carried out in area of Banjaluka and included 200 samples of soils from top soil layer (depth 0-25cm). The examined area covering about 1,239 km^2 and has moderate continental clime. It is situated in the north-western part of Bosnia and Herzegovina (Fig. 1). Town Banjaluka is administrative, economical and industrial center of this area, located in its northeastern peripheral part. Various soil types are represented in the examined area, but the cambisols and mixture of the luvisols and cambisols, and pseudogleys are predominant. These soils were formed on the geological bedrock that includes various tertiary formations like limestones, dolomites, flysch etc (Institute of Geology Sarajevo, 1976).

Figure 1. Map of the investigated area

Soil sampling was done with agrochemical probe by forming the average sample on every microlocation. Prior to chemical analysis the sub-samples were air-dried, then crushed and sieved to a particle size less than 2 mm. Total contents of the Pb were determined by method of atomic absorption spectrophotometry (Perkin Elmer AAnalyst 400, USA) after digestion with aqua regia (ISO 11466). The content of metals obtained after digestion with mixture of HNO_3+HCl (3:1) is actually pseudo-total content, because certain part of metals total content

(metal ions bound to the silicate minerals) is not dissolved from the soil. This is acceptable for the environmental analysis as it is unlikely that the silicate bound elements will leach from soil and become available (Hooda, 2010). Therefore, digestion with aqua regia is standard method for determination of the total contents of heavy metals and their allowed maximums for unpolluted soils, in most European countries (Sloot el al., 2007), as well as in Bosnia and Herzegovina (Official Gazette FBiH, 38/2011; Official Gazette RS, 26/2014).

Descriptive statistics (mean, maximum, minimum, standard deviation, coefficient of variation etc.) were calculated by SPSS version 22.0. Background values for the lead in investigated soils have been determined by application of several methods: classical [Mean ± 2σ], [Median ± 2MAD], iterative 2σ method, box plot-upper whiskers and two graphical methods: box plot and cumulative probability plot.

Results and Discussion

The total lead contents in all examined soil samples (n=200) were lower than allowed maximum for unpolluted soils (100 mg Pb kg^{-1}, Official Gazzete RS 56/2016). Determined mean of the total Pb (30,68 mg kg^{-1}) in the soils of the Banjaluka area was slightly higher than average lead content (27 mg kg^{-1}) in the worldwide soils (Kabata-Pendias and Pendias, 2011). Also, our results are in accordinance with the determined total Pb contents in the soils of the European Union countries (Toth et al., 2016). In the south and southeastern parts of the EU was mainly found average content of Pb higher than 25 mg kg^{-1} (Italy, Hungary, Greece end other countries), while in the northern parts of the region (Skandinavia, United Kingdom etc.) total Pb in average was lower, mainly due to the last glaciation period.

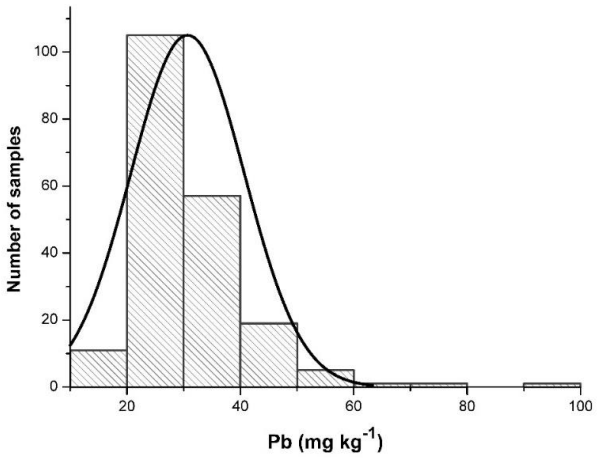


Figure 2. Total content of Pb (mg kg^{-1}) in the investigated soils

The distribution of the determined total Pb contents was close to normal redistribution (Fig. 2), as indicated also by a low coefficient of variation (CV=32%). Further statistic analysis, positive skewness and kurtosis coefficients (Tab. 1), as well as the histogram of the total Pb contents (Fig. 1) point out the right-skewed assimetrical distribution with some longer tail than in the normal distribution. That is typical for the distribution of different elements in the soils, with even more expressed departure from normal distribution (Mrvić et al., 2011; Perez-Sirvent et al., 2009), what is mainly caused with larger zone of investigation and therefore higher heterogeneity of the examined soils.

Because of the small variability of total Pb in the examined area, assessment of the background values in this work is done with natural data set. According the Reimann et al. (2005) if the CV is higher than 100% logtransformation of data is recommended.

Table 1. Total content, main statistics and background values for Pb (mg kg^{-1})

Mean	30,68	Median	28,53
Standard deviation	10,02	MAD	31,70
Q1	54,50	Mean+2σ	50,72
Q3	143,00	Median +2 MAD	41,65
Interquartile range	88,50	Upper whisker calcul.	47,02
Coefficient of variation (%)	32,65	Mean+2σ inter.	36,13
Skrewness coefficient	2,46	Outer limit-graphic method	46,16
Kurtosis coefficient	11,11	Average of the obtained values	44,43

Determined background values of the lead in the investigated soils are shown in the Tab. 1. The highest background value (50,72 mg Pb kg^{-1}) was established with classical [Mean+2σ] method. This was expected in view of the conclusions reached by Mattschulat and al. (2000). On the other side the lowest value (36,13 mg Pb kg^{-1}) were obtained by iterative mean+2σ technique. According Erhardt and collaborators (1998) in this technique mean and standard deviation are calculated for the original data set, while all values out of the interval mean ± 2σ are excluded. This procedure is continued until all remaining values lie in the before mentioned range. As this technique approximate the data set the obtained background value is lower than in other used methods.

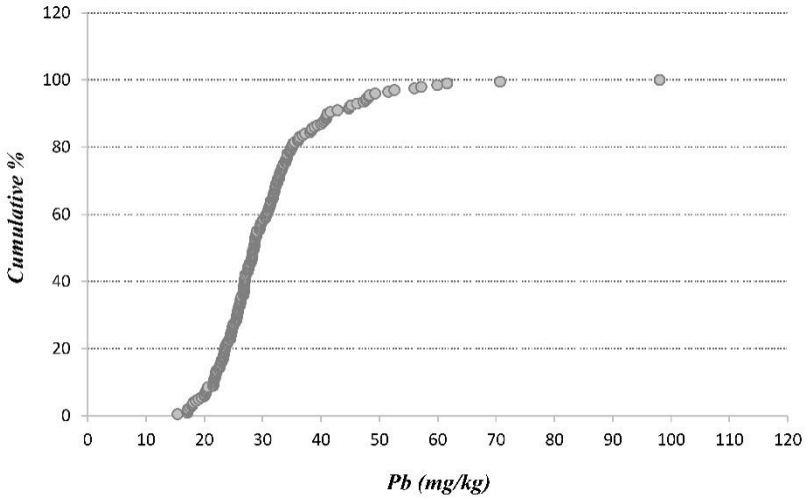


Figure 3. Cumulative probability graph for the total Pb contents

By graphical methods (Fig. 3, Fig. 4) in the examined area were established as background value 46,16 mg Pb kg^{-1}. On the cumulative probability plot are clearly visible more inflection points in the whole data set. Since estimation of the background value from cumulative probability plot is to a large extent based on subjective assessment, it is adviceable to use this graph in the combination with other extension diagrams (Mrvić et al., 2011) such as box plot used in this work.

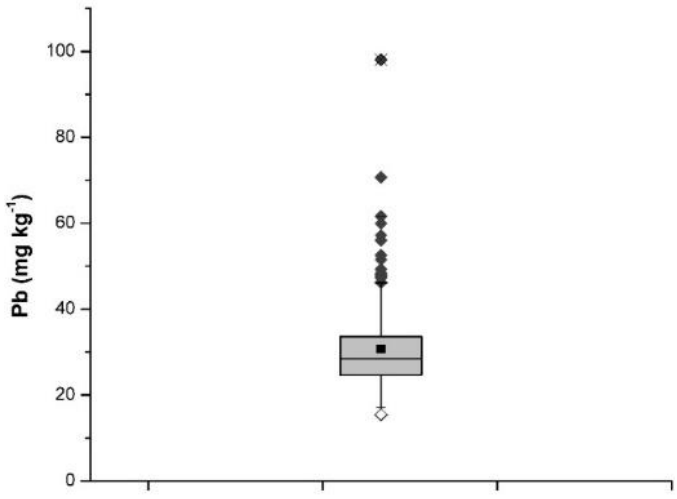


Figure 4. Box plot diagram of the total Pb contents

The mean of the all values determined by use of different criteria in this work is 44,43 mg Pb kg^{-1}. It is recommendable to use this value as basic point in further environmental studies (calculating the EF, Igeo and similar criteria), as well as for management and monitoring of the soil quality in the examined area, especially in the industriall and urban zones of the town

Banjaluka which require protection, remediation and sanitation measures. Also, it is interesting to point out that the background value for the total Pb determined in this work were lower than the upper background limit (threshold) for the total Pb in the soils: 60 mg kg^{-1} proposed by standards of the Ministry of the Environmental in Finland (2007) which was used as basic in cathegorization of soil quality according the lead content in a recent environmental studies in Europe and Australia (Toth et al., 2016; Reimann and Caritat, 2017). According this criteria risk of the environmental pollution with lead from the examined soils is on a low level.

Conclusion

The results of the research carried out in the soils of the area Banjaluka showed that the investigated soils are not polluted with Pb, because determined total content of Pb in all examined soil samples was lower than maximum allowed for the unpolluted soils (100 mg kg^{-1}). The average background value of the total Pb in the investigated soils was 30,68 mg kg^{-1}, with a range of the determined values between 15,41-98,06 mg Pb kg^{-1}, what imply to predominantly occurrence of Pb in the investigated soils from geological origins, with some anthropogenic loads, probably from traffic, agriculture and other. Beside this, it was found that the background value of the Pb is in range between 36,13 and 50,72 mg kg^{-1}, with the mean of 44,43 mg kg^{-1}. Considering these results it is possible to determine the impact of the lead from the soil on the environment and to find out any possible exchanges in the background values caused by variation of different anthropogenic influences in the future.

References

Diez, M., Simon, M., Martin, F., Dorronsoro, C., Garcia, I. & Van Gestel, C.A.M. (2009). Ambient trace element background concentrations in soils and their use in risk assessment. *Science of the Total Environment*, 407, 4622-4632.

Erhardt, W., Höpkerm, K.A. & Fischer, I. (1998). Verfahren zur Bewertung von immissionsbedingten Stoffanreicherungen in standardisierten Graskulturen. V.: Auswertung und Darstellung von Meßergebnissen aus Bioindikationsverfahren. Z Umweltchem Ökotox8: 237-240.

Galuszka, A. & Migaszewski, Z.M. (2011). Geochemical background-an environmental perspective. *Mineralogia*, 42, 1, 7-17.

Hooda, P.A. (2007). *Trace Elements in Soils*. Blackwell Publishing Ltd.

Institute of Geology Sarajevo (1976). *Geological map SFRJ 1:100000 Banjaluka*, L33-199 ed. Federal Institute of Geology Belgrade.

International Agency for Cancer Research (1990). *Chromium, nickel and welding*. Lyon, France: IARC, 257-445.

International Standard Organization (1995). *Soil quality*. Extraction of trace elements soluble in Aqua Regia, ISO 11466.

International Standard Organization (2005). *Soil quality*. Guidance on Determination of Background Values. ISO 19258. Anex E.

Kabata-Pendias, A. & Pendias, H. **(**2011). *Trace elements in Soils and Plants*, 4th ed., Boca Raton, FL, CRC Press LLC.

Matshullat, J., Ottenstein, R. & Reimann, C. (2000). Geochemical background-can we calculate it? *Environmental Geology*, 39(9), 990-1000.

MEF / Ministry of the Environment, Finland (2007). *Government Decree on the Assessment of Soil Contamination and Remediation Needs,* 214/2007.

Mrvić, V., Kostić-Kravljanac, Lj., Zdravković, M., Koković, N., Perović, V., Čakmak, D.B. & Nikoloski, M. (2011). Methods for assessment of background limit of Ni and Cr in soils of Eastern Serbia. *Field and Vegetable Crops Research*, 48, 189-194.

Mrvić, V., Kostić-Kravljanac, Lj., Sikirić, B, Delić, D &. Jarmaz, D. (2014). Methods for the assessment of background limits of Cd and Cr in soil of Moravički district. *Bulletin of the faculty of Forestry*, 109, 137-148.

Newton, D.E (2010). *Chemical Elements*, 2nd edition, Gale Cengage Learning.

Official Gazette Federation of Bosnia and Herzegovina (2011). *Rulebook on the methodology for monitoring the condition of agricultural soil.* No. 26/11 (in Serbian).

Official Gazette Republic of Srpska (2014). *Rulebook on conditions and methodology for testing the fertility of agricultural soil and determination the amount of mineral fertilizers and pesticides.* No. 26/14 (in Serbian).

Official Gazette Republic of Srpska (2016). *Rulebook on allowed amounts of hazardous and harmful materials in agricultural soils and water for irrigation and applied methods for their determination.* No. 56/16 (in Serbian).

Perez-Sirvent, C., Martinez-Sanchez, M. J., Garcia-Lorenco, M. L., Molina, J. & Tudela, M. L. (2009). Geochemical background levels of zinc, cadmium and mercury in anthropically influenced soils located in a semi-arid zone (SE, Spain). *Geoderma*, 148, 307-317.

Prasad, M.N.V. (2008). *Trace Elements as contaminants and nutrients:* Consequences in ecosystem and human health, John Whiley and Sons, Inc., Hoboken, New Yersey.

Reimann, C. & Garret, R.G. (2005). Geochemical background-concept and reality. *Science of the Total Environment*, 350, 12-27.

Reimann, C., Filtzmoser, P. & Garret, R.G. (2005). Background and threshold: critical comparison of methods of determination. *Science of the Total Environment*, 346, 1-16.

Reimann C. & Caritat, P. (2017). Establishing geochemical background variation and threshold values for 59 elements in Australian surface soil. *Science of the Total Environment*, 578, 633-648.

Rodrigues, A.S.L., Malafaia, G., Costa, A.T. & Nalini Junior, H.A. (2013). Background values for chemical elements in sediments of the Gualaxo do norte river basin, MG, Brazil. *Revista de Ciencias Ambientais*, Canoas, 7(2), 15-32.

Sloot, H.A., Heasman, L. & Quevauviler, Ph. (1997). Harmonization of leaching / Extraction tests, Elsevier science, Neatherland.

Toth, G., Hermann T, Da Silva, M.R. & Montanarella, L. (2016). Heavy metals in agricultural soils of the European Union with implications for food safety. *Environment International*, 88, 299-309.

Turkey, J.W. (1977). *Exploratory data analysis*. Reading, PA: Addison-Wesley.

Zglobicki, W., Lata, L., Plak, A. & Reszka, M. (2011). Geochemical and statistical approach to evaluate background concentrations of Cd, Cu, Pb and Zn (case study: Eastern Poland). *Environmental Earth Sciences*. 62, 347-355.

Granice prirodnog sadržaja olova u zemljištima grada Banja Luke

Mihajlo Marković[1], Dijana Mihajlović[1], Svetlana Antić-Mladenović[2], Milan Šipka[1]

[1] Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Bulevar vojvode Petra Bojovića 1A, 78000 Banja Luka, Bosna i Hercegovina

[2] Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd, Srbija

Autor za korespondenciju: Dijana Mihajlović, dijana.mihajlovic@agro.unibl.org

Sažetak

Cilj ovog rada je određivanje ukupnih sadržaja i granica prirodnog sadržaja olova (Pb) u zemljištima na području grada Banja Luka. Istraživanjem je obuhvaćeno 200 uzoraka obradivog zemljišta, uzetih iz oraničnog sloja (dubine 0-25cm). Ukupni sadržaji Pb su određeni metodom atomske apsorpcione spektrofotometrije nakon kiselinske digestije (HNO_3+HCl). Granice prirodnog sadržaja olova su određene primjenom nekoliko metoda: klasična [Mean ± 2σ], [Median ± 2MAD], iterativna 2σ metoda, boks plot –proračun i grafičke metode (boks plot dijagram i kriva kumulativne vjerovatnoće). Ukupni sadržaj Pb u svim ispitanim uzorcima (interval: 15,41-98,06 mg Pb kg^{-1}) je bio niži od dozvoljenog maksimuma (100 mg Pb kg^{-1}). Utvrđena prosječna vrijednost granica njegovog prirodnog sadržaja za područje grada Banjaluke je 44,34 mg Pb kg^{-1}. Dobijeni rezultati ukazuju da na dominantno geohemijsko porijeklo Pb u ispitivanim zemljištima, sa mjestimičnim antropogenim uticajima.

Ključne riječi: teški metali, spoljašnja sredina, zagađenje, rizik

Review paper

EU policy on food quality and legislative framework in Bosnia and Herzegovina

Dragan Brenjo, Džemil Hajrić

Agencija za bezbjednost hrane BiH, Mostar, Bosna i Hercegovina

Cooresponding author: Dragan Brenjo: brenjo@fsa.gov.ba

Abstract

Priorities of Europe 2020 Strategy include goal of achievement of competitive economy based on science and innovations as well as promotion of high-employment economy delivering social and territorial cohesion. In order to achieve better recognizability of products, to promote products with specific characteristics and to protect producers from unfair practice at the same time, quality policy of agricultural products should enable appropriate resources to producers. Only if their efforts are fairly awarded, producers can continue production of various high-quality products. That requires their ability to inform customers and consumers on the importance of their products subject to fair market competition. Additionally, they have to identify their products on the market properly. In this way, systems of quality could contribute to and complete policy of rural development and policies of market and income support to Common Agricultural Policy (CAP). Particularly, systems of quality could help to areas with high economic significance of agricultural sector and to areas with impeded economic conditions.

The area of protection of foodstufs by designation of origin, geographical indication and traditional specialities guaranteed designation in Bosnia and Herzegovina was, inter alia, subject of recommendations of European Commission and technical conclusions of the 1st EU-BiH SAA Sub-Committee on agriculture and fisheries in 2016, with the recommendation to approximate legislation in Bosnia and Herzegovina to Regulation (EU) No 1151/2012.

Council of Ministers of Bosnia and Herzegovina on its 157th session adopted a Rulebook on quality systems for foodstuffs (Official Gazette of BiH, No 90/18) which is approximated to Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November

2012 on quality schemes for agricultural products and foodstuffs and Commission Implementing Regulation (EU) No 668/2014.
The Rulebook prescribes registration process for designations of origin, geographical indications, and traditional specialities guaranteed in Bosnia and Herzegovina and procedure of submition of the application for registration on EU level as well.

Key words: Food Quality, legislation in B&H

Introduction

European policy for food quality - history

Europe is renown for its variety of livestock and agricultural products, arising from the differences in natural environments and land cultivation methods, developed through centuries. Together with excellent culinary, European food and drink play main role in determining cultural identity of European peoples and regions. Top agriculture quality in the EU is the key for its success (Common Agriculture Policy of the EU).
During the 1980s, certain production sectors in the EU introduced production quotas. At the same time, there was a need for improved food quality, as a mean to, on one hand, achieve offer-demand balance and the reduction of the surplus on the other. Some of the EU member states developed their own regulations to encourage production and protection of specific product names (European policy for quality agricultural products). However, these regulations were significantly different from country to country, creating barriers for trade on the Union common market.
Since, in the light of these circumstances, the goal was to encourage agricultural production diversification in order to achieve offer-demand balance on markets, and the production of products with specific characteristics could be of use for rural economy, particularly in underdeveloped and distant, less populated areas, a common EU solution was necessary (Regulation (EEC) No 2081/92). In addition to that, a better education on nutritive and protection traits of food and increased purchasing power of consumers in the European Union resulted in consumers paying more attention to the food quality than to quantity. This led to the increased demand for food with recognizable geographic origin which are important part of culture and tradition of a region (Guidelines for registration of designation of origin, geographical indications, and traditional specialities guaranteed).

In practice, it meant to accept unified approach, create equal and just conditions for producers' competitiveness in the EU, as well as foresee trade with third countries which offer equal guarantees for this issue (Regulation (EEC) No 2081/92).

The result of these activities are: the Regulation (EEC) No 2081/92 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs and the Regulation (EEC) No 2082/92 on certificates of specific character for agricultural products and foodstuffs. By adopting the Regulation (EEC) No 2081/92, production, processing and distribution of agricultural and foodstuffs with recognizible geographical origin started playing more important role in the Union economy. By 20 March 2006 there were already 678 products protected at the EU level. 379 of these products were labeled with the protected designation of origin (PDO), 284 with the protected geographical indication (PGI), and 5 with the traditional specialties guaranteed (TSG) (DOOR - http://ec.europa.eu/agriculture/quality/door/list.html).

Since the framework of the Union regulations regarding the protection system allowed development of labels for geographical origin and increased trust of consumers in these products, in order to clarify and explain the procedures, the Council of Europe adopted the Council Regulation (EEC) No 510/2006 of 20 March 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs and the Council Regulation (EEC) No 509/2006 of 20 March 2006 on agricultural products and foodstuffs as traditional specialities guaranteed. The number of protected products was still increasing, and by 21 December 2012 there were 1.106 protected products at the EU level. 534 out of them were labelled PDO, 535 PGI, and 37 TSG (DOOR - http://ec.europa.eu/agriculture/quality/door/list.html).

The priorities of the Strategy Europe 2020, identified in the Commission Communication "Europe 2020: A European strategy for smart, sustainable and inclusive growth", include goals for achieving competitive economy based on knowledge and innovation and promoting economy with high employment rate which creates social and territorial cohesion. Policy of agricultural products quality should allow producers the right means to achieve better recognizability and promotion of products with specific characteristics whilst protecting the producers against unfair practices (Regulation 1151/12).

One of the more important advantages which allows the EU producers competitive advantage and contributes to its lively cultural and gastronomic heritage is the quality and diversity of production in agriculture, fishery and aquaculture. This is the result of skills and determination of farmers and the Union producers who have preserved tradition and at the same time respected development of new production methods and materials (Regulation 1151/12).

Producers may continue with the production of diversified quality products only if their efforts are adequately awarded. This requires them to be able to inform buyers and consumers on the significance of their products subject to fair market competition. In addition to that, they need to properly identify their products on the market. This way the systems of quality can contribute and build on rural development policy as well as market policies and income contribution of Common Agricultural Policy (CAP). They can particularly contribute to areas with higher economic significance and to areas with impeded economic conditions (Regulation 1151/12).
For the purpose of simplifying the EU CAP legal environment it is necessary to apply new approach on regulations in the area of policy of agricultural products quality, without challenging specificity of those products. Hence the Regulation of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs was adopted. The Regulation (EU) No 1151/2012, in addition to already existing quality labels, prescribes a system of optional quality term in order to allow producers to inform consumers more easily of characteristics of agricultural products with added value (Regulation 1151/12).
The term "mountain product" has been introduced, as an optional quality term in order to ensure producers in mountain areas the mean for more successful market placement of their products and to reduce the real risk from creating confusion among consumers regarding mountain origin of products on the market. Furthermore, "product of island farming" has also been introduced as a term to be used only for products which raw materials come from islands when it significantly affects specific characteristics of final products (Regulation 1151/12).

Legal framework in Bosnia and Herzegovina

Food characteristics contributing to its ability to satisfy the needs of end consumers refer to "food quality" (Law on Food). Food business operators are allowed to place food of predefiend quality on market, as well as food for which quality requirements are not predefined, if such food is in compliance with the health marks regulations and information on label (Law on Food).
Food of insufficient quality is:
a) food which does not meet the required quality standards,
b) incompletely, inadequately, or improperly labelled food,
c) unauthorised use of someone else's trademark and commodity code (Law on Food).

However, apart from prescribed basic and fundamental prerequirements for health and food safety, quality characteristics are connected to:

- particular product characteristics, often connected to the geographical origin or production region (e.g. mountain regions), animal species or a production method (i.e. organic agriculture);
- specific food additives;
- specific production methods, often result of local knowledge and tradition;
- meeting high standards of environmental protection and animal welfare;
- processing, preparation, presentation and labelling of products in ways which improve product attractiveness in the eyes of consumers (European policy for agricultural products quality).

Food quality system in BiH is regulated by following legal regulations:

- Rulebook on designation of origin and geographical indications of food (The Official Gazette BiH, No 27/10);
- Rulebook on traditional speciality food (The Official Gazette BiH, No 27/10), and
- Rulebook on the design and the manner of use of the designation of origin, georgraphical indications and traditional specialities guaranteed (The Official Gazette BiH, No 81/12), proposed under the Law on Food (The Official Gazette BiH, No 50/04) by the Food Safety Agency in cooperation with the competent bodies of entities and Brčko District BiH, and adopted by the Council of Ministers BiH.

These rulebooks are in line with the following regulations of the European Union:

- Council Regulation (EC) No 510/2006 of 20 March 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs;
- Council Regulation (EC) No 509/2006 of 20 March 2006 on agricultural products and foodstuffs as traditional specialities guaranteed;
- Commission Regulation (EC) No 1898/2006 of 14 December 2006 laying down detailed rules of implementation of Council Regulation (EC) No 510/2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs, and
- Commission Regulation (EC) No 1216/2007 of 18 October 2007 laying down detailed rules for the implementation of Council Regulation (EC) No 509/2006 on agricultural products and foodstuffs as traditional specialities guaranteed.

Discussion

Adopted Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs refers to establishing systems of quality as bases for labelling, and when appropriate, protection of names and terms, which are specific for agricultural and food products.

The protection of food products by designation of origin, geographical indications and traditional specialities guaranteed in Bosnia and Herzegovina is, *inter alia*, a subject of the European Commission recommendations and technical conclusions from the First Session of Sub-committee for Agriculture and Fishery between the European Union and Bosnia and Herzegovina, held in Brussels on 29 June 2016, with the recommendation to harmonize regulations with the Regulation EU 1151/2012; the area of geographical indications in BiH should also be harmonized with the Law on Wine provisions, which should be in line with the EU *acquis*. Furthermore, the result of the Third Session of the Sub-Committee, held in Brussels on 7 November 2018, was the Recommendations with the list of activities for BiH, and the following recommendation was for the system of quality: "BiH should continue amending its legislation in the area of national geographical designations protection".

The Council of Ministers, at its 157th session, held on 7 November 2018, at the proposal of the Food Safety Agency BiH (hereinafter: the Agency) in cooperation with the competent bodies in the entities and the Brčko District BiH, adopted the Rulebook on quality systems for foodstuffs (hereinafter: the Rulebook) (The Official Gazette BiH, No 90/18) partially harmonized with:

- Commission Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs, and
- Commission Implementing Regulation (EU) No 668/2014 of 13 June 2014 laying down rules for the application of Regulation (EU) No 1151/2012 of the European Parliament and of the Council on quality schemes for agricultural products and foodstuffs pravila za primjenu Uredbe (EU) br. 1151/2012.

The Rulebook prescribes the process of protection of designation of origin and geographical indications, and the procedure of protection of traditional specialities guaranteed on the territory of BiH, as well as the procedure for submitting the application and objection for designation of origin, geographical indications and traditional specialities guaranteed at the European Union level.

When the Rulebook entered into force the following rulebooks expired:

- The Rulebook on designation of origin and geographical indications for foodstuffs (The Official Gazette BiH, No 27/10), and
- Rulebook on traditional specialities guaranteed designation for foodstuffs (The Official Gazette BiH, No 27/10).

The Rulebook entered into force on 26 December 2018 and the Agency has, during the first four months of 2019, officially received four applications for the geographical designations:

- "Visočka pečenica", request for the protected geographical indication (PGI)
- "Nevesinjski krompir", request for the protected geographical indication (PGI)
- "Livanjski izvorni sir", request for the protected designation of origin (PDO)
- "Livanjski sir", request for the protected geographical indication (PGI)

The registration procedure for protected designation of origin, protected geographical indications and traditional specialities guaranteed designations is initiated by submitting an application to the Agency. The applicant must enclose the following documents:

a) completed application form for registration of a foodstuff by protected designation of origin or protected geographical indication under Anex II of the Rulebook on quality systems for foodstuffs;
b) copy of evidence for the registration of the group;
c) the statement of a competent body of the group on adopted decision on protected designation of origin and geographical indications for a foodstuff;
d) power of attorney (if the group is represented by an authorized representative), notarized;
e) product specification in accordance with Article 7 of the Rulebook on quality systems for foodstuffs;
f) completed form of a single document under Annex III of the Rulebook on quality systems for foodstuffs;
g) certificate from the body competent for the assessment of compliance in order to be able to complete certification;
h) name and the address of the group submitting the application and the bodies, if available, which conducts the assessment of compliance with the regulations of the product specification.

The applicant for traditional specialities guaranteed designation must enclose the following documents to the Agency:

a) completed application form for traditional specialities guaranteed designation under Annex X of the Rulebook on quality systems for foodstuffs;
b) copy of evidence for the registration of the group;
c) the statement of a competent body of the group on adopted decision on traditional specialities guaranteed designation for a foodstuff;
d) power of attorney (if the group is represented by an authorized representative), notarized;
e) product specification in accordance with Article 26 of the Rulebook on quality systems for foodstuffs, and a completed form under Annex IX of the Rulebook;
f) certificate from the body competent for the assessment of compliance in order to complete certification.

The procedure is conducted by the Commission for registration of protected designation of origin and geographical indications for foodstuffs in BiH, i.e. the Commission for awarding traditional specialities guaranteed designation appointed by the Council of Ministers BiH, at the proposal of the Agency, in cooperation with the competent bodies in the entities and the Brčko District BiH.

The fee rate for the registration procedure is prescribed by the Decision on fee rates for registration of protected designation of origin, geographical indication, and traditional specialities guaranteed designation (The Official Gazette BiH, No 86/16).

In BiH, the Institute for Accreditation of BiH (BATA) is the competent body for the accreditation of entities and assessment of compliance. In accordance to the Rulebook on quality systems for foodstuffs (The Official Gazette BiH, No 90/18) for protected designation of origin, geographical indications and traditional specialities guaranteed for foodstuffs, the control of compliance with the specification is conducted by one or more control bodies acting as bodies for assessment of compliance authorized by the Council of Ministers BiH. The bodies for assessment of compliance need to be accredited by the Institute for Accreditation of BiH or another international body authorized for the accreditation in accordance with the BAS EN ISO/IEC 17065 standard. The bodies for assessment of compliance from other countries should submit evidence in one of the official languages in Bosnia and Herzegovina that they are accredited for confirmation of harmonization with the product specification and a written statement that all procedures and record keeping shall be in one of the official languages in Bosnia and Herzegovina.

The bodies for assessment of compliance for products with a protected designation of origin, geographical indication, and traditional specialities guaranteed designation are authorized in accordance with the Decision on authorisation for legal entities for protected designation of

origin and geographical indication (The Official Gazette BiH, No 86/16). Currently, there is one body for assessment of compliance in BiH.

Designations, acronyms and trademarks referring to quality systems can be used only in connection with the products produced in compliance with the rules on quality systems they apply to, in a way prescribed by the Rulebook of quality systems for foodstuffs (The Official Gazette BiH, No 90/18).

In BiH, the Rulebook of official controls performed for the verification of acting in accordance with the regulations on food and feed and regulations on animal health and animal welfare (The Official Gazette BiH, No 5/13 and 62/17) is in force and it is in line with the Regulation (EU) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules. The Rulebook lays down general rules on performing official controls as well as competent bodies for its implementation.

Conclusion

The specificity of geographical position, natural potentials and rich tradition allow Bosnia and Herzegovina to successfully compete with its diverse offer of domestic foods products and traditional specialities. However, the consequence of administrative vagueness is that so far the emphasis has not been on product protection, primarily in BiH, and subsequently at the EU level, as prescribed by the EU legislation.

Normative regulation of the food quality system in Bosnia and Herzegovina has been recognized by a number of producers and they reacted in a way that they have initiated the process of the protection of products which they have grown, produced and processed through generations on their farms, generations of local families. Additionally, local communities, consumers and the media have recognized that food and drink play important role in determining cultural identity and promoting local cultural heritage of regions, most commonly mountain and underdeveloped areas.

References

Commission Regulation (EU) No 1151/2012 of the European Parliament and of the Council of 21 November 2012 on quality schemes for agricultural products and foodstuffs.

Commission Implementing Regulation (EU) No 668/2014 of 13 June 2014 laying down rules for the application of Regulation (EU) No 1151/2012 of the European Parliament and of the Council on quality schemes for agricultural products and foodstuffs.

Council Regulation (EEC) No 2081/92 of 19 July 1992 on the protection of geographical indications and designation of origin for agricultural products and foodstuffs.

The Official Gazette BiH, No 90/18: Rulebook on foodstuff quality systems.

The Official Gazette BiH, No 86/16: Decision on authorizing legal persons for designation of origin and geographical indications for foodstuffs.

The Official Gazette BiH, No 86/16: by the Decision on fee rate for the registration procedure for designation of origin, geographical indication and traditional specialities guaranteed designation.

The Official Gazette BiH, No 5/13 i 62/17: Rulebook of official controls performed for the verification of acting in accordance with the regulations on food and feed and regulations on animal health and animal welfare.

The Official Gazette BiH, No 81/12: Pravilnik o izgledu i načinu korištenja znaka oznake originalnosti, oznake geografskog porijekla i oznake tradicionalnog ugleda hrane.

The Official Gazette BiH, No 27/10: the Rulebook on designagtions of origin and geographical indications for foodstuffs.

The Official Gazette BiH, No 27/10: Rulebook on traditional specialities guaranteed designation.

The Official Gazette BiH, No 50/04: Law on Food.

European policy for food quality: http://www.seerural.org/wp-content/uploads/2009/05/02_EVROPSKA-POLITIKA-ZA-KVALITET-POLJOPRIVREDNIH-PROIZVODA.pdf .

Agricultural and rural development: DOOR - http://ec.europa.eu/agriculture/quality/door/list.html.

Guidelines for registration of designation of origin, geographical indications, and traditional specialities guaranteed: http://www.fsa.gov.ba/fsa/images/izdavacka/bs-Smjernice_za_registraciju_oznaka_originalnosti_geografskog_porijekla_i_tradicionalnog_ugleda_hrane.pdf.

Common Agricultural Policy EU: http://www.seerural.org/wp-content/uploads/2009/05/04_ZAJEDNICKA-POLJOPRIVREDNA-POLITIKA-EU.pdf

Politika kvaliteta hrane EU i pravni okvir u BiH

Dragan Brenjo, Džemil Hajrić

Agencija za bezbjednost hrane BiH, Mostar, Bosna i Hercegovina

Autor za korespondenciju: Dragan Brenjo, brenjo@fsa.gov.ba

Sažetak

Prioriteti Strategije Evropa 2020 uključuju ciljeve postizanja konkurentne privrede zasnovane na znanju i inovacijama te promovisanju privrede s visokim stepenom zaposlenosti koja stvara socijalnu i teritorijalnu koheziju. Politika kvaliteta poljoprivrednih proizvoda morala bi omogućiti proizvođačima prava sredstva za postizanje bolje prepoznatljivosti i promociju onih njihovih proizvoda koji imaju posebna svojstva dok u isto vrijeme štiti te proizvođače od nepravedne prakse.

Proizvođači mogu nastaviti proizvoditi raznovrsne kvalitetne proizvode samo ako je njihov trud pravedno nagrađen. To zahtijeva da su oni u stanju obavještavati kupce i potrošače o značaju svojih proizvoda pod uslovima pravednog tržišnog takmičenja. Pored toga, moraju pravilno identifikovati svoje proizvode na tržištu. Na ovaj način sistemi kvaliteta mogu doprinijeti i nadopuniti politiku ruralnog razvoja kao i politike tržišne i dohodovne podrške zajedničke poljoprivredne politike (ZPP). Posebno mogu doprinijeti područjima u kojima poljoprivredni sektor ima veći privredni značaj te područjima s otežanim privrednim uslovima. Oblast zaštite prehrambenih proizvoda oznakama porijekla, geografskog porijekla i tradicionalnog ugleda hrane u Bosni i Hercegovini je, između ostalih, bila i predmet preporuka Evropske komisije i tehničkih zaključaka sa 1. sastanka Podoodbora za poljoprivredu i ribarstvo između EU i BiH iz 2016. godine, sa preporukom da se trebaju uskladiti propisi sa Uredbom EU 1151/2012.

Na 157. sjednici Savjeta ministara BiH donešen je Pravilnik o sistemima kvalitete za prehrambene proizvode (“Službeni glasnik BiH”, broj 90/18) koji je usklađen sa Uredbom (EU) broj 1151/2012 o sistemima kvaliteta za poljoprivredne i prehrambene proizvode i Provedbenom uredbom (EU) br. 668/2014. Ovim Pravilnikom propisuje se postupak zaštite oznaka porijekla, geografskog porijekla i garantovano tradicionalnog specijaliteta na području BiH, kao i postupak za podnošenje zahtjeva za registraciju na nivou Evropske unije.

Ključne riječi: Kvalitet hrane, zakonodavstvo u BiH

Review paper

Opportunity cost of serbian agricultural exports

Milan R. Milanović[1], Simo Stevanović[2]

[1]*Megatrend University, Faculty of State Management, Goce Delčeva 8, 11070 Belgrade, Republic of Serbia*

[2]*University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080 Belgrade, Republic of Serbia*

Corresponding author: Milan R. Milanović, mmilanovic@megatrend.edu.rs.

Abstract

In this paper a dynamic quantitative model of a system of functionally related equations is made, which enables the quantification of opportunity costs. The total opportunity cost of agraricultural export of Serbia was determined by calculating the costs and value of production, foreign trade and the prices of corn and pork in the period 2000-2015. The aim of the paper is to examine the phenomenon of opportunity costs in concrete examples, with a comparative analysis of trends in production, consumption, exports, imports and prices of inputs. The opportunity cost was determined on the basis of the difference in the increased export of corn and unrealized domestic production and increased imports of pork meat.

Key words: transitional distortion, opportunity cost, corn export, meat import.

Introduction

The negative tendencies in the trends in Serbia's agriculture in the last 25 years have, on the one hand, been a consequence of the bad concept of the agrarian policy, whereas on the other, of the wrong privatization of big economic entities in primary production and the processing industry. The negative trends are reflected in the stagnation or fall in production, the extensification of the production structure, the monopolization of the market, the instability and deterioration of the structure of the foreign-trade exchange of agro-industrial products.

Irrespective of the negative trends, agriculture is still considered as an important economic field of the foreign-trade exchange of the Serbian economy.

The concept of the neoliberal policy of developed countries, international and regional associations and organizations has an influence on the position of the domestic agriculture on the global world market, the EU market and the markets of the countries of the former Yugoslavia.

For a longer period already, we have been aware of the tendencies of the extensification of the structure of the Serbian agrarian export, with an increasingly greater share of cereals, raw and unprocessed products. On the other hand, there has been an increase in the import of meat, milk and other animal products, whose production is for the most part based exactly on the domestic production of cereals, especially corn. Such a tendency has specially been pronounced in the last ten years or so, when the unit export value of the majority of the most important export products, with distinct oscillations, has been about $200-300, but mainly less than $1,000 per ton (Milanović, Stevanović, 2013).

On the basis of the increased export of the raw materials of the primary agricultural products and the growth of the import of the agricultural products of a higher stage of finalization, one part of the GDP of the Serbian economy flows over to developed countries. The goal of the paper is to indicate - on the example of the increased export of corn, as a raw material in the nutrition of pigs, and the import of pork as a product of a higher stage of finalization – the losses of a part of the GDP incurred as an opportunity cost of the foreign-trade exchange of these two products.

In order to determine the opportunity costs of the export of corn and the import of pork, an analysis of the trends in the production, consumption, export, import and prices of the raw materials (corn) and the final products (pork) in Serbia in the period from 2000 to 2015 was carried out.

The data were obtained from the websites of the Statistical Office of the Republic of Serbia, the Competent Ministries of the Government of the Republic of Serbia and other domestic and international publications.

The Features of the Structure of Production and the Agrarian Export of Serbia

The dynamics of the Serbian overall agricultural production during the twenty-five pre-transition and post-reform years (1991-2015) shows an exceptional cyclical instability, stagnation or a very slowed down growth, with the significant differences between plant production and animal husbandry. High annual oscillations (chain indices) in plant production range from minus 30 to plus 50 index points. The annual oscillations of animal husbandry are also relatively high, given its biological specificities and production inertia, but within the range of plus/minus 10 index points (Milanović & Đorović, 2011).

In comparison with 1990, the plant production indices record a sinusoid slight growing trend, whereas those related to animal husbandry show a falling parabola. Although it moves sinusoidally, plant production records a slight growth, whereas animal husbandry has a pronounced negative trend, which is around 20% lower today than in the initial period.

The most significant long-term characteristic of Serbia's agrarian export and import is the process of the extensification of the export structure, which can also be understood as the expression of the production-resource structure, as well as the indicator of the level of agrarian techno-economic development. Prior to the beginning of the transition, the leading export products were those from the field of animal husbandry (bovine cattle, fresh meat, canned meats) as a more developed segment of overall agriculture at that time. Today, at the end of the process of transition reforms and the promised "social well-being", the agrarian-production and the export structures are reformed by "moving backwards": among the leading export products there are no livestock products, whereas the main export products are mainly raw materials, primarily grains (Milanović, 2013).

Apart from the production-structural extensification (with a long-term trend of decreasing the share of animal husbandry as the main feature), as well as the deepening of the overall structural-systemic asymmetries of domestic agrarian circumstances in comparison with those European (Milanović et. al., 2006, 2014), the process of the pronounced extensification of the structure of foreign-trade exchange, with the two unfavorable flows, is certainly the characteristic expression of the indicated unfavorable trends. The first reflects in an increase in the share of raw materials and unprocessed agricultural products in agrarian export, whereas the second, even more unfavorable, reflects in an increase of the import final products, which certainly could be substituted with the domestic production of the same, exactly on the basis of using the raw materials that are exported.

Bearing in mind their reproduction interconnectedness, from the macroeconomic standpoint, the import of such final products is the *opportunity cost* of the export of primary (unprocessed) products.

The Opportunity Cost Model

The opportunity cost, which is considered as "the best founded principle in economics" by some authors (Pirs, 2003) expresses the hidden value of the alternative activity that we have relinquished in relation to the selected option. This concept starts from the assumption that some value that has been achieved could have been greater if some other, i.e. the next best combination of the available resources had been selected. Such a concept starts from the two facts: the first - that the resources/factors of production are limited/rare, and the second – that it is possible to use those resources alternatively, i.e. that, within the framework of the production possibilities of an economy as the given magnitude, it is possible to alternatively use the existing limited factors of production for the purpose of conducting different activities (Milanović, 2009a).

If resources were unlimited, one activity would not be conducted to the detriment of another (theoretically, all of them could be carried out), so the opportunity cost of any selected activity as the value of "the next best" alternative would not exist, either (it would be equal to zero). However, "it is clear that in the real world of rarities the opportunity cost is positive" (Pirs, 2003).

Every choice that has an alternative bears a possibility of a certain sacrifice when the same is being made. Once a choice has been made and once an economic resource has been used for some economic activity, the other possibilities of having that resource used have been sacrificed for the purpose of the selected activity. The difference between the best activity of the used resource and its accomplished economic activity represents the opportunity cost of the conducted-selected economic activity.

It arises from the character of the opportunity cost that, beside economics, it can also be applied in the other spheres of human activity. Namely, each alternative decision has its opportunity cost[6].

[6] In its primary meaning, the verb *decidere* (decide) means "cut off", derived from the Latin prefix *de* and the verb *ceadere* (cut). By that very fact, every decision made in connection with some situation we may experience in our lives, "cuts off" all the other decisions that might have been made (Milanović, 2009a).

The macroeconomic perception of the opportunity cost requires using resources at the maximum level of production possibilities. An example of the opportunity cost will be demonstrated in agriculture, starting from the following assumptions:

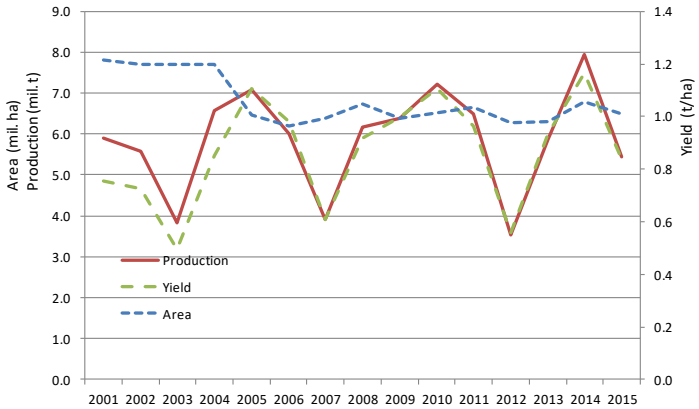
- let only two products, wheat (A) and corn (B), be produced on the overall agricultural areas;
- beside the possibility of the alternative use of the other substitutive factors as in industry (of labor and of capital) within the framework of the given production potential, here the analysis includes agricultural land as the key production factor that is naturally limited (natural monopoly);
- it is also assumed that the applied level of agro-technics enables the optimal utilization of the genetic potential of the cultivated sorts and hybrids of these grain varieties.
- let 3m tons of wheat (A) and 5m tons of corn (B) be produced on the available land in one year;
- if there is an intention/wish to increase the production of wheat (A) to 4m tons (*ceteris paribus*, namely not taking into account any possible changes in productivity, the price parity and so on) in the next year;
- then, given the fact that the total production possibilities are limited (labor and capital, and primarily the land), the production of corn (B) would have to be proportionally reduced (by 5:3), so instead of 5m tons, it is possible to produce 3.3m tons.

This hypothetical example shows that, in the assumed conditions, the production of one additional million ton of wheat would "cost" that economy as the opportunity cost (it is clear – not as an accounting cost) the equivalent value of the amount of 1.7 million tons of corn. (Even assuming that the unit prices of these products are equal, the net opportunity cost would amount to 0.7m tons.) An increase in the production of one economic good (A) requires a sacrifice – a reduction in the production of a certain quantity of another good (B). Exactly this sacrificing of one good in favor of another in economics represents the opportunity cost. A hidden loss that appears due to the non-production of that other good is the opportunity cost of the production of the first. In other words, the opportunity cost is the most highly valued benefit that has to be sacrificed due to making a choice of a certain production alternative (Milanović, 2009b).

An Example of the Opportunity Costs of Agrarian Export

The agrarian-economic phenomenon of the opportunity costs of agrarian export can be perceived on the examples of the two characteristic products: the export of mercantile corn, on the one hand, and the import of meat and processed meats, particularly the import of pigs and pork, on the other. Simultaneously, the opportunity costs of the export of corn can be derived from the increased value of the import of livestock and meat, which appears as a consequence of unachieved potential domestic production, i.e. the unachieved alternatively possible increase in domestic production and the export of meat on the basis of the available (but exported) amounts of corn as the basic livestock input. So, the differential cost of the overall macroeconomic production-export results of the selected, or in a concrete economic-systemic environment, the encouraged agrarian structure and export orientation is perceived. Therefore, it is crucial that a comparative analysis on the domestic production trends, the consumption, export, import and reference prices of these products should be carried out.

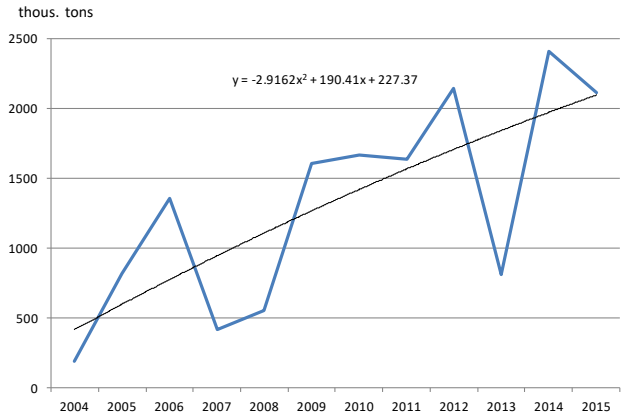
Since the resources of the agricultural land in Serbia on which corn is produced are relatively limited, from the point of view of the engagement of the basic resource, the production of corn can be considered to have reached the upper limit of the production possibilities, which may mean that its production is resource-limited. In the period from 2001 to 2015, the average reaped areas under corn in Serbia were being reduced at the rate of -1.32% (from 1.2m ha in 2001 to 1.0m ha in 2015). With big oscillations (from 3.5m tons in 2012 to 8.0m tons in 2014), the average corn production was being reduced at the rate of -0.57% and was around 5.9m tons. Even though the yields in the three years were extremely low (from 3.5 t/ha in 2012 to 3.8 t/ha in 2003), the average corn yields were being increased at the rate of 0.76% and were around 5.6 t/ha.



Graph 1. The features of corn production in Serbia 2001-2015

Source: Author's calculation, Statistical Office of the Republic of Serbia (RZS)-Database http://webrzs.stat.gov.rs

The structure of the use of the produced (domestic) corn was changing towards in the direction of increasing exports, i.e. the relative reduction in that part intended for domestic reproduction consumption in animal husbandry. In the period from 2004 to 2015, together with the pronounced annual fluctuations, 15.69m tons of corn, or 1.31m tons on average per annum, were exported in total. The value of the total exported corn was $3.29 bn, i.e. $273.8m on average per annum. In comparison with the achieved production, the export averagely reached over one-fifth (21.60%) of the total crop, with a tendency of a relative increase after 2010. In 2015, 2.12m tons, or the total of 38.77% of that year's total corn production (5.45m tons), were exported.



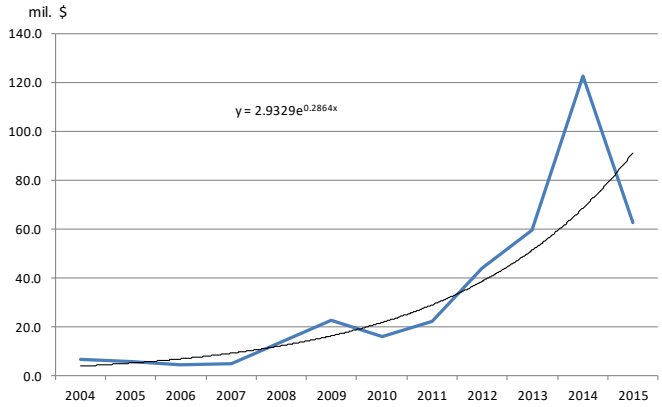
Graph 2. Corn Export from Serbia in 2004-2015

Source: Author's calculation, Statistical Office of the Republic of Serbia (RZS)-Database http://webrzs.stat.gov.rs

In the official corn balances[7], too, in the period from 2004 to 2015, it is possible to observe a rapid decrease in the use of corn for fodder by one whole million tons (from 4.9 to 3.9m tons). On the other hand, if we observe the usage structure of such a resource-limited output, i.e. a possibility of an alternative use of domestic corn, by directing it to direct export or, yet, to reproduction consumption (animal husbandry) and the creation of domestic products of a higher stage of processing (primarily livestock, meat, milk and eggs), whose import, however, has rapidly been growing, then on the basis of the analysis of the effects of these two activities, the import of cattle, meat, dairy products and eggs can be regarded as the opportunity cost of the export of corn.

[7] The Orientational Corn Balance, http://www.mpzzs.gov.rs/dokumenti/ (accessed on May 2017).

In the period 2004-2015, in parallel with the increase in the export of corn, a very significant increase in the import of livestock products (the three SITC sections: live animals without breeding animals; meat and meat preparations; dairy products and eggs) was recorded both with respect to the quantities and the values: from 18.3 thous. tons in 2004, the export increased to 124.6 thous. tons in 2014, or 89.3 thous. tons in 2015, whereas the value of the import increased from $39.9 to $260.5m in 2014 (almost 7 times as much), or $174.9 thous. in 2015. Only the import of pork in the period 2006-2014 (fresh, chilled, frozen) was continuously being increased from 4.5 thous. tons only to amount to 35.6 thous. tons in the last year. In the nine years, the import of pork was increased about eight times. The import of live pigs multiply increased from the symbolical 37 tons in 2006 to 26.9 thous. tons in 2014[8] (80 times).

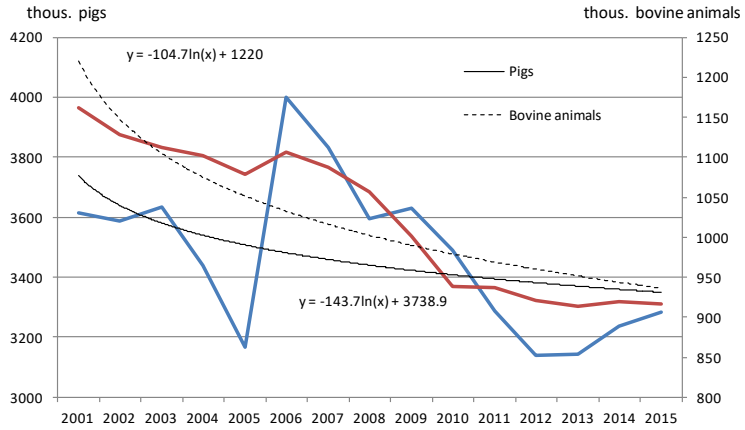


Graph 3. The import of pigs and pork to Serbia in 2004-2015

Source: Author's calculation, Statistical Office of the Republic of Serbia (RZS)-Database http://webrzs.stat.gov.rs

According to the pig and pork balances in 2001-2015, we can observe a significant decrease in the number of the head from 4.0m (in 2007) to 3.1m (in 2014), i.e. by 22.5%. The big oscillations of the import of live pigs were also recorded, from 928 thous. in 2001, via the absence of imports in 2006 to 172 thous. in 2015. In the mentioned period, the domestic consumption of pork moved from the lowest 294.5 thous. tons in 2009 to the highest 327.7 thous. tons in 2014.

[8] Statistical Office of the Republic of Serbia, Database, http://webrzs.stat.gov.rs/WebSite/Public/ReportResult (accessed on April 2017).



Graph 4. The number of the head of bovine animals and pigs in Serbia in 2001-2015

Source: Author's calculation, Statistical Office of the Republic of Serbia (RZS)-Database http://webrzs.stat.gov.rs

The changes in the bovine animal and beef balances in the period 2001-2015 were yet more unfavorable: the number of the head decreased from 1.2m to 920 thous. (23%), whereas the domestic production of meat moved from 95.0 thous. tons in 2007 to 68.5 thous. tons in 2013. The import of beef increased from 17 tons in 2007 to 1.1 thous. tons in 2014 (over 60 times), whereas the export decreased from 9.5 thous. tons in 2007 to 2.5 thous. tons in 2014 (by 4 times). The domestic consumption of beef fell from 91.0 thous. tons in 2009 to 72 thous. tons in2014 (22%)[9].

The total value of the export of unground corn (as a raw material) in the period 2001-2015 reached $3.29bn, i.e. averagely $273.8m per annum. Simultaneously, the total value of the import of pork[10] in the period 2004-2015 was $216.1M, i.e. averagely $18.0m per annum.

Starting from the assumption that, from the macroeconomic standpoint, taking into consideration the size and the structure of the gross domestic product, which also includes the level of the employment of the workforce in labor-extensive crop farming or in labor-intensive animal husbandry (Milanović, Stevanović, 2014), as well as the sectoral differences in the creation of value added, it is less economically efficient to export raw materials than to export preparations and highly-finalized products, we can speak about the *two aspects of the opportunity costs of corn export*, as the product that is conditionally limited with respect to the quantity from the points of view of resources and production:

[9] Statistical Office of the Republic of Serbia (RZS)-Database, http://webrzs.stat.gov.rs and http://www.mpzzs.gov.rs/dokumenti/ (accessed on May 2017).

[10] Pork carcasses and halves, fresh, chilled; Pork carcasses and halves, frozen; Pork legs (hams) and shoulders/butts, fresh, chilled; Pork legs (hams) and shoulders/butts, frozen; Other pork, fresh or chilled; Other pork, frozen.

(a) the substitution of the import of livestock products on the basis of an increase in their domestic production on the available domestic agro-ecological and other potentials (a greater domestic use of corn), and

(b) the creation of an export offer and an increase in the export of meat and meat preparations as final products on the basis of a greater domestic reproduction consumption of corn, the greater employment of the workforce, a greater value added and, ultimately, the greater export value of the final livestock products.

Beside the degree of the competitiveness of domestic products, the key obstacle in the realization of such commitments is the constantly present (direct or indirect) agrarian protectionism and interventionism of the developed countries on the agrarian market that abundantly subsidized both the producers and the exporters of agrarian products for the purpose of protecting their own production. The programs of state interventionism have not been formalized with respect to the model to follow for a long time, but over time their analysis has evolved towards the economic effects of the distribution of income and costs among different interest groups (Lovre, Zekić, 2011).

The concept of the opportunity cost that can be solved by means of complex differential calculations enables us to select the best economic activity in the given production possibilities from the point of view of the lowest opportunity costs, i.e. a more rational satisfaction of macroeconomic goals.

Conclusion

From the macroeconomic aspect, the analysis of opportunity costs on the example of the export of corn and the import of pork from and to Serbia, respectively, in the period 2001-2015 is indicative of the fact that the export of raw materials (mercantile corn) is less efficient than the export of highly-finalized (processed) livestock products. The analyzed model encompasses the two aspects of the opportunity costs of the export of corn as a possibility for a greater domestic reproduction consumption with the aim to: *first*, substitute the import on the basis of the increased production of domestic livestock products, and *second*, to additionally increase animal husbandry with the aim to increase the export of meat and meat preparations.

Even though a rarely surplus branch of the Serbian economy is in question, the unfavorable structure of agrarian export can be fixed by exporting the products of a higher stage of processing, which highly-finalized processed livestock products also belong to.

A greater production of highly-finalized livestock products, simultaneously decreasing the export of corn, achieves positive changes in both the agrarian structure of export and the greater

employment of the workforce in labor-intensive animal husbandry to the detriment of a decrease in labor-extensive crop farming. A greater stage of the finalization of the livestock products intended for export ensures an additional increase in the value of agrarian products and finally a greater export value of the final livestock products and the overall agrarian export.

References

Lovre, K. & Zekić, S. (2011). *Ekonomska analiza agrarnih programa*. Ekonomski fakultet, Subotica.

Milanović, M. (2002). Agrarni izvoz kao izraz komparativne efikasnosti agroindustrije. *Ekonomski anali* (tematski broj), oktobar 2002, Beograd.

Milanović, M. (2006). Istraživanje agrarno-razvojne pozicije Srbije u Evropi. *Megatrend Revija,*Vol. 3.(2) 2006, Beograd, 25-42.

Milanović, M., Vasiljević, Z. & Njegovan, Z. (2006). Promene u zaposlenosti i strukturi radne snage u evropskoj i srpskoj poljoprivredi. *EP*, 2/2006(53) TB(597-607). Beograd.

Milanović, M. (2009a). *Ekonomija prirodnih resursa,* Megatrend univerzitet, Beograd.

Milanović, M. (2009b). *Mali ekološko-ekonomski leksikon*. Naučno društvo agrarnih ekonomista Balkana, Beograd.

Milanović, M. & Đorović, M. (2011). *Tržište poljoprivrednih proizvoda u Srbiji pre i posle tranzicije* (monografija). IEP, Beograd.

Milanović, M. & Stevanović, S. (2013). *Potentials of the agrarian-export competitiveness of Serbia in the new eu-Danube basin*. Thematic Proceedings, International Scientific Meeting, December 5-7, 2013, Topola, Serbia, IAE, Belgrade, 434-451.

Milanović, M. (2013). *Long-term structural changes in the Agrarian Market in Serbia (1990-2010): Cyclicality of production, Oligopolistic of demand, Extensive growth of export.* In Monogrph: Agri-food sector in Serbia: state and challenges. Serbian Academy of Sciences and Arts, Board for Village, Belgrade, 119-142.

Milanović M., Stevanović S. & Vićentijević D. (2013). Konkurentnost i potencijali agrarne spoljne trgovine Srbije. *Teme*, G. XXXVII, Br. 1, 297-317.

Milanović, M. & Stevanović, S. (2014). *Labour force as a (non)renewable resource in agriculture of Serbia*. Thematic Proceedings, International Scientific Conference, IAE, Belgrade, Serbia, June, 5-6th, 2014, 360-376.

Pirs, Dejvid, V. (2003). *Moderna ekonomija* (prevod prema četvrtom Mekmilanovom izdanju). Dereta, Beograd.

http://webrzs.stat.gov.rs/WebSite/Public/Report

Professional paper

Results of monitoring pesticide residues in and on food of plant and animal origin on the market of Bosnia and Herzegovina in 2018

Dragan Brenjo, Džemil Hajrić, Dragan Tomović

Food Safety Agency of Bosnia and Herzegovina, Kneza Višeslava bb, 88000 Mostar, Bosnia and Herzegovina

Cooresponding author: Dragan Brenjo, brenjo@fsa.gov.ba

Abstract

Monitoring the residues of pesticides in and on food aims to determine the amount of residues of pesticides and their metabolites in selected products, to check whether they comply with regulations setting maximum residue levels (MRLs) of pesticides, comply with the principles of good agricultural practice (GAP) and assessment of nutritional acute exposure and chronic exposure of consumers to the residues of pesticides and thus contribute to protecting the health of consumers. Within the monitoring of pesticide residues in 2018 a total of 195 samples of food were sampled. 165 active substances were analyzed in 20 different product categories, of which 157 products of plant origin, 16 animal products and 22 products from the category of processed cereal-based foods for infants and young children. Out of 195 samples of domestic origin there were 108 or 55.4%, while import samples were 87 or 44.6%. In total, 20 different products were monitored. Pesticide residues at the quantification level did not contain 104 samples, 91 samples (46.6%) contained pesticide residues in/above the quantification level. Of the 165 active substances analyzed, 126 were not found in concentrations that allow quantification in any analyzed sample. In the case of 40 active substances, values that allow quantification in one or several analyzed products are determined. Of the total of 195 samples taken from 20 foods, samples from five foods did not contain pesticide residues. Three samples (1.54%) were above the MRL, but within the limits of measurement uncertainty, and these samples are considered appropriate. The samples were made of table grapes, apples and eggplants. One pear sample was not compliance (0.51%), and residues of the active substance

(Chlorpyrifos) were found, above the prescribed MRL, taking into account the measurement uncertainty.

Key words: pesticides, monitoring, MRL pesticides, fruits and vegetables

Introduction

Pesticide residues in and on food of plant and animal origin are the result of the use of plant protection products, biocidal products, and in veterinary medicine. Pesticide residues present in and/or on food include active substances, their metabolites and/or active substance degradation products or reaction products currently being used or previously used in plant protection products, biocidal products, and in veterinary medicine. Pesticide residue level depends on the amount of a plant protection product used, time elapsed from the last treatment of the crop, i.e. pre-harvest interval, number of applications, physical-chemical products, and on agricultural crop the product is applied on.

The purpose of pesticide residue in and on food control programme is to determine the level of pesticide residues and their metabolites in food of plant origin and check if they are in accordance with the Rulebook on maximum levels of pesticide residues in and on food and feed of plant and animal origin (The Official Gazette BiH, No 89/12 and 92/17) and if the producers are in compliance with Good Agricultural Practice (GAP) principles, as well as to assess acute and chronic exposure of consumers to pesticide residues introduced by food and to contribute to consumers' health protection, and to check if the plant protection products are used adequately, i.e. in accordance with the Law on Plant-Protection Products BiH (The Official Gazette BiH, No 49/04). The monitoring programme for pesticide residues in and on food of plant and animal origin is divided into several phases: sampling, sample treatment, identification of pesticides presence and determining their residues level, potential quick risk assessment, and report preparation.

Sampling was conducted in accordance with the Rulebook on sampling methods for conducting official control of pesticide residues in and on products of plant origin and animal origin (The Official Gazette BiH, No 78/12). The said Rulebook is in line with the Directive 2002/63/EC of 11 July 2002 (Commission Directive 2002/63/EC of 11 July 2002 establishing Community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin and repealing Directive 79/700/EEC).

The Rulebook on maximum levels of pesticide residues in and on food and feed of plant and animal origin prescribes the highest level of a pesticide residue allowed in a product of plant and animal origin. The products with the maximum residue level (MRL) higher than permitted cannot be placed on the market of Bosnia and Herzegovina prior to risk assessment for exposure of consumers to unsafe food of plant origin, which is conducted by the Food Safety Agency of Bosnia and Herzegovina.

Special maximum level for pesticide residues is determined by the provisions of the Rulebook on processed cereal-based foods and baby foods for infants and young children (The Official Gazette No 86/13) in line with the Directive 2006/125/EC and 2006/141/EC. Considering the precautionary measures, maximum level set for this product type is low (limit of quantification); set MRL of 0.01 mg/kg is applicable unless lower MRL is determined by the Rulebook.

MRL is the highest pesticide residue concentration level in or on food of animal origin set based on good agricultural practice and the lowest necessary exposure of consumers for the purpose of protection of vulnerable consumers groups. MRL is expressed in mg/kg of a product. Limit of quantification (LOQ) is the lowest pesticide residue concentration which can be set and published as a result of routine control with validated control methods.

The term “samples without pesticide residues in measurable amounts” is used to describe the results of analyses not present in concentrations at or above limit of quantification (LOQ), and the term “samples with quantified pesticide residues within the permitted level (under or at the MRL)” is used to describe samples containing limits of quantifications of residues of one or several pesticides concentrations under or at the MRL.

Unsuitable samples are samples with residue concentrations which exceed permitted limits, taking into consideration the measurement uncertainty as well. The official control in case of analytical measurement should take into account measurement uncertainty as well, prior to the administrative sanctions against the food company for the infringement regarding MRL (Codex, 2006; Ellison and Williams, 2012; European Commission, 2018).

For the purpose of harmonization with the EU Guidance document on analytical quality control and method validation procedures for pesticides residues analysis in food and feed (SANTE/11813/2017), during monitoring laboratories should take measurement uncertainty into account the when determining excess of the maximum residue limits (MRL) of pesticides. Measurement uncertainty refers to the accuracy achieved when measuring pesticide concentration (residue level) in the analysed sample. Measurement uncertainty describes the range around the result within which it is expected to find actual level in accordance with the

defined probability (certainty level); this does not mean that a doubt is expressed in regards to the presence, or the identity of pesticide residue measured. If measurement uncertainty is subtracted from the determined MRL excess in accordance with the SANTE guidelines, and the remaining concentrations are lower than MRL, then the MRL excess falls within the measurement uncertainty, and the sample is deemed suitable. It is important to note that the EU guidelines on 50% measurement uncertainty refer only to monitoring and taking measures – official controls, but not to analyses conducted by another party or on behalf of companies.

Material and Methods

The Food Safety Agency of Bosnia and Herzegovina in cooperation with the Administration of Bosnia and Herzegovina for Plant Health Protection and the Veterinary Office of Bosnia and Herzegovina, have developed the multiannual control programme in line with the coordinated multiannual control programme implemented in the EU member states for the period 2018-2020, i.e. in accordance with the Commission Implementing Regulation (EU) 2017/660 of 6 April 2017 concerning a coordinated multiannual control programme of the Union for 2018, 2019 and 2020 to ensure compliance with maximum residue levels of pesticides and to assess the consumer exposure to pesticide residues in and on food of plant and animal origin. In addition to the part harmonized with the EU Regulation, the control programme includes national products selected based on the results of the existing control programme for pesticide residues in and on food, the product importance from the aspect of food consumption, RASFF notifications, and other parameters.

Under the Control (monitoring) Programme for the pesticide residues in and on products of plant and animal origin in 2018 (hereinafter: Control Program), monitoring of 20 different products has been conducted. In accordance with the Commission Regulation (EU)2017/660 on coordinated multiannual control programme implemented in the EU member states 2018-2020, which is the basis for the Control Programme development, a total of 16 different products have been selected: table grape, banana, grapefruit, applem pear, melon, aubergine, broccoli, cultivated mushrooms, pepper, wheat grain, virgin olive oil, beef tallow, chicken eggs, cow milk, processed baby food.

In addition to the listed products, four domestic products have also been sampled (plum, raspberry, gherkin, and cucumber); they were selected based on the results of the existing control programme for pesticide residues in and on food, the product importance from the

aspect of food consumption, RASFF notifications and other parameters. Sampling has been conducted in three phases. A total of 195 samples have been selected:105 fruit samples, 70 vegetable samples and 20 samples of other food categories (fruit or vegetables purees for kids or purees based on vegetables, wheat grain/wheat flour and cultivated mushrooms).

There were 195 samples in total, out of which 100 samples were in the Federation FBiH, 85 in the Republika Srpska, 10 in Brčko District BiH (Figure 1). Sampling was conducted in 33 cities/municipalities: Banja Luka, Bihać, Bijeljina, Bratunac, Brčko, Breza, Bugojno, Cazin, Čapljina, Čitluk, Doboj, Goražde, Gradačac, Gradiška, Istočno Sarajevo, Laktaši, Livno, Mostar, Orašje, Prijedor, Prozor, Ravno, Sarajevo, Srebrenica, Široki Brijeg, Travnik, Trebinje, Tuzla, Ugljevik, Velika Kladuša, Visoko, Zenica and Živinice. Under the Control Programme a total of 165 active substances residues were monitored in 157 products of plant origin, 16 products of animal origin, and 22 products from the category of processed cereal-based foods and baby foods for Infants and Young Children.

The laboratory which conducted analyses of samples needed to meet the following requirements:

- to be accredited in accordance with the ISO 17025 standard,
- to have accredited multi-residue and single-residue methods for detection of pesticide residues in products under Monitoring in accordance with the requirements from the document SANTE/11945/2015,
- to mandatory participate at the international Proficiency Test (PT),
- when applying multiresidual method it can apply qualitative orientational method on maximum of 15% samples taken and analysed in accordance with the Control Programme.

If the results of the qualitative orientational method are positive, it is necessary to apply a standard target method for quantifying results.

Results and Discussion

A total of 195 samples have been selected, out which 104 did not contain pesticide residues at the limit of quantification, 91 samples (46.6%) contained pesticide residues at/above the limit of quantification. 126 active substances, out of 165 analysed in products of plant and animal origin, were not detected in concentrations allowing quantification, nor in any of the analysed samples (number in brackets represents a total number of samples analysed for a specific active substance): 2,4-D (50), 2-phenylphenol (165), acephate (165), aldicarb (165), aldrin (195),

dieldrin (195), azinphos-methyl (165), bifenthrin (165), biphenyl (195), bitertanol (165), bromide ion (20), buprofezin (165), carbofuran (165), chlordane (40), chlorfenapyr (165), chlormequat (50), chlorpropham (165), clofentezine (155), cyfluthrin (165), cymoxanil (165), cypermethrin (195), cyproconazole (165), cyprodinil (165), cyromazine (50), DDT (40), dicloran (165), dicofol (155), diethofencarb (165), dimethoate (165), diniconazole (165), dithianon (20), dithiocarbamates (145), dodine (165), endosulfan (195), epoxiconazole (165), ethephon (40), ethion (165), ethirimol (155), etofenprox (195), famoxadone (165), fenamidone (165), fenamiphos (165), fenarimol (155), fenazaquin (155), fenbutatin oxide (50), fenhexamid (165), fenitrothion (165), fenpropathrin (165), fenpropidin (165), fenpropimorph (165), fenpyroximate (165), fenthion (165), fipronil (165), flonicamid (70), fluazifop-p (50), flubendiamide (165), fludioxonil (165), flufenoxuron (165), fluopicolide (165), fluquinconazole (165), flusilazole (165), flutriafol (165), formetanate (165), fosthiazate (165), glyphosate (30), haloxyfop (50), heptachlor (40), hexachlorobenzene (40), hexachlorocyclohexane (hch) (40), hexaconazole (165), hexythiazox (155), iprodione (165), iprovalicarb, kresoxim-methyl, lindane (40), linuron (165), lufenuron (165), malathion (165), mepanipyrim (165), mepiquat (30), methamidophos (165), methidathion (165), methiocarb (165), methomyl and thiodicarb (165), methoxychlor (40), monocrotophos (165), myclobutanil (165), oxadixyl (165), oxamyl (165), oxydemeton-methyl, paclobutrazol, parathion (195), penconazole, pencycuron, pendimethalin, phosmet, pirimicarb (165), pirimiphos-methyl (195), procymidone (165), profenofos (165), propamocarb (70), propargite (165), propiconazole (30), propyzamide, prosulfocarb, prothioconazole, pymetrozine (40), pyridaben (165), pyriproxyfen (165), spinosad (165), spirodiclofen (165), spiroxamine (165), tau-fluvalinate (165), tebufenozide (165), tebufenpyrad (155), teflubenzuron (165), tefluthrin (165), terbuthylazine (165), tetraconazole (165), tetradifon (155), thiophanate-methyl (165), tolclofos-methyl (165), tolylfluanid (155), triazophos (165), triflumuron (165) i vinclozolin (165).

For 40 active substances, values allowing quantification in one or several analysed samples were determined (number in brackets next to active substance represents a total number of samples with the quantified pesticide residues/unsuitable samples): abamectin (165/3/0), acetamiprid (165/12/0), acrinathrin (165/8/0), azoxystrobin (165/18/0), boscalid (165/23/0), bromopropylate (165/1/0), captan (165/1/0), carbaryl (165/3/0), carbendazim (165/5/0), chlorantraniliprole (165/13/0), chlorothalonil (165/3/0), chlorpyrifos (195/2/1), chlorpyrifos-methyl (195/1/0), clothianidin (165/2/0), deltamethrin (195/2/0), diazinon (195/2/0), dichlorvos (165/1/0), diflubenzuron (165/3/0), dimethomorph (165/7/0), diphenylamine (165/1/0), fenbuconazole (165/1/0), fenoxycarb (165/1/0), fenvalerate (195/8/0), fluopyram (165/5/0), imazalil (165/5/0),

imidacloprid (165/8/0), indoxacarb (175/5/0), lambda-cyhalothrin (165/1/0), mandipropamid (165/2/0), metalaxyl (165/1/0), permethrin (195/22/0), pyraclostrobin (165/4/0), pyrimethanil (165/1/0), spiromesifen (165/6/0), tebuconazole (165/5/0), thiabendazole (165/8/0), thiacloprid (165/4/0), thiametoxam (165/1/0), triadimefon (165/2/0).

Among active substances analysed in plant products, the following were quantified in more than 5% analysed samples: boscalid (13,9%), permethrin (11.3%), azoxystrobin (10.9%), chlorantraniliprole (7.9%), acetamiprid (7.3%).

Food samples of animal origin (milk and beef tallow) were analysed for total of 22 active substances and residues were not quantified in any of the samples. Taking into account the measurement uncertainty active substance residues were detected in 14 samples within the measurement uncertainty.

Table 1. Samples with active substance residues within the measurement uncertainty

No.	Active substance	Product	Determined value		Prescribed MRL
1	Dimethomorph	Grapefruit	0.01	(±0.005)	0.01
2	Dimethomorph	Grapefruit	0.01	(±0.005)	0.01
3	Azoxystrobin	Cultivated mushrooms	0.01	(±0.005)	0.01
4	Dimethomorph	Banana	0.01	(±0.005)	0.01
5	Thiametoxam	Gherkin	0.01	(±0.005)	0.01
6	Carbendazim	Wheat grain	0.086	(±0.043)	0.1
7	Bromopropylate	Aubergine	0.039	(±0.019)	0.05
8	Abamectin*	Table grape	0.011	(±0.006)	0.01
9	Diazinon*	Apple	0.014	(±0.007)	0.01
10	Dichlorvos	Aubergine	0.01	(±0.005)	0.01
11	Diazinon*	Aubergine	0.015	(±0.008)	0.01
12	Spiromesifen	Pear	0.019	(±0.095)	0.02
13	Spiromesifen	Apple	0.018	(±0.009)	0.02
14	Spiromesifen	Table grape	0.016	(±0.008)	0.02

* Samples with excess levels of MRL, within a measurement uncertainty.

Three samples (1.54%) were above MRL, but within a measurement uncertainty, and these samples were deemed suitable (See Table 1). One sample was unsuitable (0.51%). It was domestic pear, in which active substance residue above prescribed MRL was determined (chlorpyrifos). Laboratory analyses results showed that 46 products contained active substances residues listed in the List of active substances approved for the use for plant protection products in Bosnia and Herzegovina. Detected active substances residues are following (number in brackets represents number of products in which active substance

residues were detected): dichlorvos (1), diazinon (2), fenvalerate (8), carbendazim (5), permethrin (22), carbaryl (3), diphenylamine (1), bromopropylate (1), diflubenzuron (3). Products with unapproved active substances residues detected were from: Bosnia and Herzegovina (23); Turkey (4); Italy (2); South Africa (2); Brazil (1); Serbia (1); Croatia (1); Poland (1); Spain (1).

Out of 195 samples taken from 20 food types, five (25.0%) did not contain pesticide residues. They were the following food types: virgin olive oil (10), beef tallow (10), chicken eggs (10), processed baby food (10), cow milk (10).

In 15 food types (75.0%), pesticide residues detected were at or above the limit of quantification. The food types were following (number in brackets represents a total number of food samples/number of samples containing pesticide residues at the limit of quantification): apple (12/11); grapefruit (10/10); banana (10/9); pear (11/9); brocolli (10/8); table grape (10/8); aubergine (10/7); raspberry (11/6); gherkin (5/5); cucumber (5/2); plum (11/5); pepper(10/4); cultivated mushroom (10/3); melon (10/3); wheat grain (10/1).

Conclusion

Out of 195 samples tested in 2018, 91 of them (46,6%) contained pesticide residues at the limit of quantification. In 2018, three samples (1.54%) contained pesticide residues over prescribed MRL, within the measurement uncertainty, and were deemed suitable. Only one sample was unsuitable (0.51%), therefore a total of four samples (2.0%) contained pesticide residues higher than MRL. The sample containing pesticide residues over the set MRL was a sample of domestic pear, in which active matter was also detected (chlorpyrifos), over the set MRL. Quick risk assessment showed exceeding acute reference dosage, and it can be considered that the same represented the health risk for consumers. Pear samples are included in the Control Programme based on the results from the previous year and a high level of quantification, and show significance and the effect which targeted controls can have in detecting the excess level of MRL.

The Agency with the relevant inspection bodies sent the Information on conducted food sampling during 2018, reports on laboratory analyses of samples ans recommendations for adequate measures, since the risks have been determined in samples not in compliance with the relevant regulations.

The laboratory analyses results showed that 46 products contained residues of active

substances listed in the List of Active Substances allowed for the use in plant-protection products in Bosnia and Herzegovina. Products containing residues of unauthorised active substances originated from: Bosnia and Herzegovina (23), Turkey (4), Italy (2), South Africa (2), Brazil (1), Serbia (1), Croatia (1), Poland (1), Spain (1). Since these results are a signal on possible abuse of unatthorised active matters, relevant bodies should investigate reasons, introduce producers with the mandatory good agricultural practice, and to take corrective measures when necessary.

It has to be noted that due to their persistence some of the active matters can remain in the environment for years after their use.

References

Regulation (EC) No 396/2005 of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC.

Commission Implementing Regulation (EU) 2017/660 of 6 April 2017 concerning a coordinated multiannual control programme of the Union for 2018, 2019 and 2020 to ensure compliance with maximum residue levels of pesticides and to assess the consumer exposure to pesticide residues in and on food of plant and animal origin.

Guidance document on analytical quality control and method validation procedures for pesticides residues analysis in food and feed (SANTE/11813/2017)

Official Gazette BiH, No 50/04. Law on Food.

Official Gazette BiH, No 49/04. Law on Plant-Protection Products BiH.

Official Gazette BiH, No 89/12 and 92/17. Rulebook on maximum levels of pesticide residues in and on food and feed for animals of plant and animal origin.

Official Gazette BiH, No 78/12. Rulebook on sampling methods for conducting official control of residues of pesticides in and on products of plant and animal origin.

Official Gazette BiH, No 86/13. Rulebook on processed cereal-based foods and baby foods for infants and young children.

Rezultati monitoringa ostataka pesticida u i na hrani na tržištu Bosne i Hercegovine u 2018. godini

Dragan Brenjo, Džemil Hajrić, Dragan Tomović

Agencija za bezbjednost hrane Bosne i Hercegovine, Kneza Višeslava bb, 88000 Mostar, Bosna i Hercegovina

Autor za korespondenciju: Dragan Brenjo, brenjo@fsa.gov.ba

Sažetak

Monitoring ostataka pesticida u i na hrani ima za cilj utvrditi količinu ostataka pesticida i njihovih metabolita u odabranim proizvodima, provjeriti odgovaraju li propisima koji određuju maksimalne razine ostataka (MRL) pesticida, pridržavaju li se proizvođači načela dobre poljoprivredne prakse (GAP) i procjenu prehrambene akutne i hronične izloženosti potrošača ostacima pesticida unesenih hranom te na taj način doprinijeti zaštititi zdravlje potrošača. U okviru monitoringa ostataka pesticida u 2018. godini ukupno je uzorkovano 195 uzoraka hrane. Analizirano je 165 aktivnih materija u 20 različitih kategorija proizvoda, od toga 157 proizvoda biljnog porijekla, 16 proizvoda životinjskog porijekla i 22 proizvoda iz kategorije prerađena hrana na bazi žitarica za dojenčad i malu djecu.

Od 195 uzoraka domaćeg porijekla je bilo 108 ili 55.4%, a uvoznih uzoraka 87 ili 44.6%. Ukupno je izvršeno praćenje 20 različitih proizvoda. Ostatke pesticida na nivou kvantifikacije nisu sadržavala 104 uzorka, 91 uzorak (46,6%) je sadržavao ostatke pesticida u/iznad nivoa kvantifikacije. Od 165 aktivnih materija koje su analizirane, 126 nije pronađeno u koncentracijama koje omogućuju kvantifikaciju niti u jednom analiziranom uzorku. Kod 40 aktivnih materija, utvrđene su vrijednosti koje omogućuju kvantifikaciju u jednom ili nekoliko analiziranih proizvoda. Od ukupno 195 uzoraka koji su uzeti iz 20 vrsta hrane, uzorci iz pet vrsta hrane nisu sadržavali ostatke pesticida. Tri uzorka (1.54%) su bila iznad MRL-a, ali u granicama mjerne nesigurnosti, te se ti uzorci smatraju odgovarajućim. Radilo se uzorcima stonog grožđa, jabuke i patlidžana. Jedan uzorak kruške je bio neodgovarajući (0.51%), a utvrđeni su ostaci aktivne materije (chlorpyrifos), iznad propisane vrijednosti MRL-a, uzimajući u obzir i mjernu nesigurnost.

Ključne riječi: pesticidi, monitoring, MRL pesticida, voće i povrće

Professional paper

Goat farming: stagnation and development on the territory of Bosnia and Herzegovina

Božo Važić[1], Sara Popadić[1], Biljana Rogić[1], Vesna Gantner[2]

[1]*University of Banja Luka, Faculty of Agriculture, Banja Luka, Republic of Srpska*
[2]*Faculty of Agrobiotechnology Osijek, University of Josip Juraj Strossmayer in Osijek, Osijek, Croatia*

Corresponding author: Božo Važić, bozo.vazic@agro.unibl.org

Abstract

Thanks to the great natural abilities of adaptation to the conditions of rearing and feeding,goats are successfully used today in all parts of the world,including arid, subtropical, tropical and mountain regions.Today, around 1 bilion goats are grown worldwide.From the 1980s to the present day, the number of goats in the world has been almost doubled.As an animal species, it successfully use all production systems. Just before the arrival of the Austro-Hungarian monarchy, about 1 500 000 goats were grown in Bosnia and Herzegovina, and just about 500 000 before at the beginning of the Second World War. The tendency of reducing the number of goats was recorded during and after the Second World War, especially after the adoption of laws prohibiting the keeping of goats. The aim of this paper is to examine the stagnation of goat farming in Bosnia and Herzegovina, which followed the adoption of legal solutions and their prohibition of keeping. According to the mention legal solutions, the keeping of the Balkan goat is prohibited, but it is permissible to keep the highly productive breeds, especially the Sana's goats, under certain conditions. Today in Bosnia and Herzegovina we have between 50 000 and 60 000 goats, which is a small number if we take the importance of this products for human consumption.

Key words: goat, stagnation, legal solutions, Bosnia and Herzegovina

Introduction

The assumption is that the goat is the first species of animal that a man has domesticated in the regions of the Middle East and Iran. Goat is an animal with the extraordinary qualities, such as adaptability to breeding environment, the utilization of poor quality pasture, the possibility of overtaking large distances, a good health condition, high productivity of dairy breeds, etc.Due to the above mentioned characteristics, goat is today successful reared in all parts of the world, including arid, subtropical, tropical, mountain and flat areas in all production systems.In most parts of the world, especially in Asia and Africa, goats are kept for meat production. Constant growth of goats' number and increased production in developing countries suggest that these animals may be irreplaceable in order to satisfy the needs of a fast-growing population of people. In European countries, there arethe most productive dairy goatbreeds, from which milk is used in order to produce a great number of dairy products. Goat meat is second important products. In Bosnia and Herzegovina, as well as in the Republic of Srpska, there are a small number of goats, primarily of noble breeds and their crossbreeds, and the smallest number of goats are the indigenous Balkan goat. Through the recent history, the number of goats in Bosnia and Herzegovina has decreased. Drastic decline in the number of goats was occurring after the Second World War, following the adoption of the statutory provisions on the ban on keeping goats. The aim of this paper is to analyze the numerous conditions of goats breeding in Bosnia and Herzegovina in the 20th century. The number of goats in this region was directly affected by the Law on the Prohibition of Keeping Goats that led to a drastic reduction in their number.In addition to the stated aim of this paper, it is an explanation of the reasons for implementing this law, as an overview of the current state of the goat breeding in Republika Srpska and the Federation of Bosnia and Herzegovina.

Goat productions in the world and Europe

The goat is breeding is spread on all continents. It is highly resistant and easily adapts to different breeding systems. From goats man receives a large number of products, and for these reasons goat is of great importance to the human population. According to recent research, goats’ milk has been found to have multiple impacts on human health, while meat possesses all nutrients for growth, development and maintenance of human health.

Table 1. The number of goats in the World and Europe

Year	World	Europe
1980.	464.323	17.294
1990.	589.220	22.163
2000.	751.632	18.940
2010.	952.524	17.151
2013.	975.803	16.527

From Table 1 it can be seen that the number of goats in the world has an increasing trend, which cannot be said for Europe where the number of goats from 1980 to 2013 does not have a significant variation and ranges between 17 and 22 million. It is estimated that goats population in the world is around 1 billion, and about 570 different breeds exist, whit differentmorphological and physiological characteristics. About 96% of the world's goat population is breeding in underdeveloped and developing countries. The largest number of noble breeds of goat are breeding in Europe. The primary purpose in Europi is milk production, and the production system is intensive. The specialty of goats for high milk production and the pursuit of the greatest profit have led to the breeding of the small number of breeds in the Europe. Some indigenous breeds with less production are endangered or evan extinct. disappeared. The African continent is characterized by the largest number of breeds, which are primarily kept for meat production.

Table 2. The production of fresh goat milk in the world and Europe (1980-2013), 000 tons (FAOSTAT, 2015)

Year	World	Europe
1980.	7.738	1.856
1990.	10.170	2.161
2000.	12.744	2.512
2010.	17.164	2.638
2013.	17.957	2.526

The data presented in Table 2 indicate that the production of goat milk on a global level is constantly increasing. World production in 1980 was 7.738.027 tons, and in 2013, 17.957.372 tons of goat milk, respectively production in Europe ranged from 1.856.000 to 2.526.000 tons. Asia and Africa arecontinents with largest goat milk production. In 2013, Asia produced about 60% and Africa about 23% of total goat milk world production. The Europe, regardless of Asia and Africa, produce about 14% of the total world production of goat milk (Važić et al., 2016).

Table 3. The production of goat meat in the world and Europe (1980-2013), 000 tons, (FAOSTAT, 2015)

Year	World	Europe
1980.	1.694	115
1990.	2.656	137
2000.	3.751	124
2010.	6.619	131
2013.	5.372	112

The production of goat meat in the world is constantly increasing, and the largest meat production has been recorded in Asia and Africa. In 2013, about 71% of the total world production of goat meat was produced in Asia, and in Africa about 24% (Važić et al., 2016).

Goat production in Bosnia and Herzegovina throughout the 20th century

At the beginning of the 20th century, Bosnia and Herzegovina was part of the Austro-Hungarian monarchy. The monarchy made certain steps to improve livestock breeding in Bosnia and Herzegovina.For this purpose, a livestock farms were established at Butmir, Livno and Gacko. Just before the start of the First World War in Bosnia and Herzegovina there were about 1,500,000 goats. During the war and after war, the number of goats in Bosnia and Herzegovina started drastically to decrease, in 1939 that number was around 500,000. In that time, Bosnia and Herzegovina was part of the former Yugoslavia. The tendency of decreasing numberof goats continued during the Second World War, and especially after the war, respectively after the adoption of a law prohibiting the keeping of goats. According the mentioned law, it is forbidden to keep the Balkan breed of goats, but it is permissible to breedingnoble breeds, especially Saxon breed under certain conditions. Towards the end of the 20th and early 21st century according to FAOSTAT (2015), there are 69,365 goats in Bosnia and Herzegovina.From Table 4 it can be seen that in the territory of Bosnia and Herzegovina during the 20th century there was a drastic decrease in the number of goats.

Table 4. Number of goats in Bosnia and Herzegovina in the period from 1895 to 2009 (Šakić et al., 2011)

Year	Number of goats	Export of goats
1895.	1.447.049	(1890-1900) 477.626
1910.	1.392.565	(1900-1910) 312.514
First world war		
1921.	529.434	
1939.	475.923	
Second world war		
1946.	200.851	
1950.	129.827	
Law and legal data on the prohibition of keeping goats		
Tragic conflict in bosnia and herzegovina, 1992-1995 year.		
2009.	71.000	

In our breeding history, only goat breading experienced such drastic and frequent variations throughout the centuries. Not so long ago, just thirty years ago, it was almost inconceivable to write about the goats, especially in the least positive and affirmative. If we were then writing about goat, then it was mostly in a negative context. In our hilly and mountainous areas it is forbidden to keep goats in order to save the forests and to allow for afforestation (raising new forests). The goat in the forest leaves enormous damage, especially for young forests (Mioč and Prpić, 2011).

Legal acts on banning goat keeping in the territory of Bosnia and Herzegovina

The adoption of legal acts is a consequence of the opinion that goats are more damaging and unpopular with regard of the natural environment, primarily the forest areas, and the social impact that they are indicative of poverty, cultural and social backwardness. The first Decree on banning goat keeping in the territory of Bosnia and Herzegovina was adopted on 24 December 1947.The purpose of the Decree was to prevent the destruction of the forests, to allow for the afforestation of breaches and the reefs, and to protect the fruit growing, prohibiting the keeping of goats in the territory of the Republic of Bosnia and Herzegovina.The Decree contained 6 members, which regulated that the Ministry of Agriculture, together with the Ministry of Forestry, shall determine the time and the method of implementing the ban on keeping goats in certain areas. The Decree predicted the purchase of goats from the farmers according to the plan predicted by the Ministry of Trade and Supply in an agreement with the Ministry of Agriculture. In addition, it is emphasized in Article 4 of the Decree that the ban does not apply to keeping the Sanska breed of goats in the barn conditions. The Decree has

number 1355 and was signed by the President of the Government of the Republic of Bosnia and Herzegovina and by the Minister of Agriculture and Forestry.

The order on the implementation of the prohibition of keeping goats in certain areas was made on January 20, 1948. The order contained four chapters. In the chapter I it is written that, by 31 December 1948, must implement a total ban on breeding the goats in the folowing Public Committees with local name Srezs: Prijedor, Bosanska Dubica, Bosanska Gradiška, Srbac, Prnjavor, Glamoč, Mrkonjić Grad, Ključ, Bosnaski Petrovac, Bihać, Cazin, Velika Kladuša, Bosanska Krupa, Sanski Most, Bosanski Novi, Gacko, Ljubuški, Duvno, Livno, Prozor, Sarajevo, Fojnica, Bugojno, Travnik, Zenica, Vareš, Sokolac, Rogatica, Goražde, Tuzla, Gradačac, Bosanski Šamac, Brčko, Bijeljina, Lopare, Zvornik, Srebrenica, Vlasenica, Kladanj, Zavidovići, Maglaj, Tešanj, Doboj, Derventa, Bosanski Brod, Odžak, Modriča and Gradačac, as a region of Public City Committees: Sarajevo, Banjaluka, Prijedor, Jajce, Bihać, Mostar, Travnik, Zenica, Tuzla, Brčko, Bijeljina, Doboj, Derventa.

In the chapter II of Orderwritten that, also by 31 December 1948, must implement a total ban on breeding the goats in the following Local Committees:Bileća, Zarječke (except the village Mirilovići, Čepelica and Žudojevići), Podosoje (except the village Baljci, Bogdašići, Bijela Rudina, Granica and Šobodine), Divin (except the village Donji Davidovići, Gornji Davidovići, Zasad, Kuti and Kukuričje) of Bileća Srez; Trebinje, Zasad, Gorica (except the village Necvjeće and Jasen), Police and Lastva Sreza trebinjskog; Poplat, Borojevići, Crnjići, Hodovo, Hrgud and Berkovići of Stolac Srez; Čapljina, Tasovčići, Međugorje, Domanovići, Klepci, Dračevo, Gabela and Trebižet in the Čapljina Srez; Mostar, Blagaj, Buna Žitomislići, Čitluk, Čerin, Ljuti Dolac, Kruševo, Tepčići, Jasenica, Donje Zijemlje, Svinarina and Vijonica of Mostar Srez; Široki Brijeg, Mokro, Biogradci, Knežpolje, Rasno, Donji Mamići, Posušje and Rastičevo (except the village Trebistovo) of the Široki-brijeg or District.

In the chapter III of Orderwritten that, also by 31 December 1948, must implement a total ban on breeding the goats in the folowing Public Committees: Višegrad, Foča, Visoko, Teslić, Nevesinje, Banjaluka, Kotor Varoš, Jajce, Bosansko Grahovo, Drvar i Konjic, as well as in the area of the local committee Plana (except the villages Golobrđe, Preraca, Lađevići, Selišta, Kačanj, Dječe, Pađani, Njeganovići and Podgorje and regions : Baljci, Bogdašići, Bijela Rudina, Podsoja Bileća District. The order on the implementation of the ban of keeping the goats in certain areas has number 701, dated January 20, 1948. The order was signed by the Minister of Agriculture and the Minister of Forestry.

Proof that there was resistance during the implementation of the Regulation and the Order on the prohibition of breeding the goat, is the letter of the Executive Board of the JSB Banja Luka,

dated September 13, 1948 sent to the Ministry of Trade and Supply. In this letterwrites "Regarding your act number 12474/48 of 30 August 1948, regarding the implementation of the Regulation on the prohibition of goat holding in 1948, we report to you that in this area, until September 7, 1948, was redeemed359 males, 579 females, and 1,199 young, and a total of 2,137 goats. At the same time, we are reporting you that the ban on the keeping of goats was not fully implemented in this area. "The letter was signed by the president and secretary of the SNO Banja Luka Executive Committee.

After the Decree and Orders to ban goat keeping, in 1965 in Bosnia and Herzegovina the Law on the prohibition of keeping goats was adopted. The Low contains 7 articles, and in article 1 writes: "For the purpose of providing forests, rebuilding and protection of forests, preventing erosion and soil degradation, as well as the protection of fruit trees, the keeping of goats on the territory of the Socialist Republic of Bosnia and Herzegovina is forbidden." In the article 2 writes: "Exceptionally from the provisions of the previous article, it is permissible to keep Sanska goats in stall breeding." Other members of the Law were related to criminal provisions, which are was no small and he even predicted 30 days in prison. The Law was proclaimed on January 28, 1965 and was signed by the President of the Parliament of SRBiH.

After this Act, in 1982 amendments to the Low were adopted, which alleviated the 1965 Law on the prohibition of goat keeping. According this amendments there was allowed goat keeping, but only in the areas of karst which are not foreseen for afforestation and melioration, and agricultural land wich not foreseen for intensive agricultural production, under condition that does not cause damage to forests and agricultural production.This amendments also prescribes an area where goats can be kept, the number of goats allowed, as well as the type and way of goat keeping.The keeping of goats was allowed to the organizations of the associated labor and individual agricultural producers.

Laws of ban on goats keeping was in force in Republika Srpska until February 8, 1997, when the National Parliament of Republic of Srpska brings the Law on termination of the Law on the prohibition of goat care from January 28, 1965. In this Low was written: "The law on the ban on keeping goats is no longer valid" and "This Law shall enter into force on the eighth day after its publication in "Official Gazeta of Republic of Srpska"". The Low was signed by the President of the National Parliament of Republica of Srpska.

This policy on the ban on keeping goats has had enormous consequences for the entire economy of Bosnia and Herzegovina. The number of goats that was about 500,000 immediately before the Second World War dropped to about 70,000. Nowadays, a number of agricultural producers have realized the importance and potential of this cattle breeding industry, they have goat farms

that are predominantly oriented to milk production and represent a nucleus from which the production of goats will be developed.

Importance of goat products

The Goat is a very viable domestic animal and grateful to the breeder. From it is obtained milk, meat, skin, sackcloth and manure. About the healing of goat's milk has long been spoken of by Hippocrates. People who regularly consume goat's milk have lower levels of glucose and fat in the blood, and its advantage is rapid digestibility. In Europe almost all the amount of goat's milk are spent on cheese production. Goats milk characterized easy digestibility. Goat cheese helps in the treatment of allergic bronchitis, is a powerful factor in the renewal of lung cells, strengthens immunity and is a rich source of minerals. In addition, goat cheese is a valuable source of high quality and easily digestible proteins, and many studies show that it has anticancer effect. Beside milk, an important product of goat is meat. The goat is a fertile domestic animal and therefore produces significant amounts of raw meat. One goat in the year gives about 50 kg of quality goat meat.

Goat skin and sackcloth are important in the footwear industry, so in the household for making bunnies and similar products. Also there are used in the household (making bags, , ropes and hat covers) and in industry (carpets, brushes). From certain goat breed is also used in the textile industry (angora and cashmere). Goat manure enriches the soil with nitrogen more than manure from any other domestic animals. Today, approximately 40% of farmers in the world use, whole or partial, animal excretion to improve soil fertility. One goat annually gives about 400-500 kg of manure.

The justification for the adoption of legal acts on ban keeping of goats in Bosnia and Herzegovina

Bosnia and Herzegovina has ideal conditions for goat farming. When the habits of goats are taken into consideration and their ability to adjust to inaccessible territory, a perfect place for goat breedingis Herzegovina and other similar areas of Bosnia and Herzegovina. The disappearance of the goats almost ceased the use of these areas for agricultural purposes, and a larger number of the population emigrated to other places. When taking into account the number of goats in developed European countries, even in the world, it can be seen that the same has increased or stagnated. In our country almost, this branch of animal husbandry was completely destroyed. In developed European countries, there were knowledge about the

importance of goat production, and for these reasons, steps were taken to improve existing breeds, especially in terms of increasing milk production. In Europe about 3% of the world's overall goat population is grown and 14% of the total amount of goat milk in the world is produced. All the passed legal acts on banning the keeping of goats did not achieve their goals, they only devastated the production of goat farming and inflicted unacceptable damage to livestock production. If we were followed the developments in the European production and the world, we would now have developed one branch of livestock, which is profitable and would be recognizable by the goat products that are required on the world market. All the acts on banning goat keeping definitelywere not justified.

Conclusions

Goat farming in developed and developing countries had a significant place in the animal production, which was not the case in Bosnia and Herzegovina.Compared to other domestic animals, the number of goats in the world has had the greatest progress, and in the last 30 to 40 years their number has almost doubled. Increase number of goats in the world was followed by an increase in the quantity of goat products. In our country the number of goats in relation to the world has constantly decreased, as well as production of their products. The reason for reducing the number of goats in our country can be related to legal solutions that prohibited the holding of goats or were allowed to hold under certain conditions. Towards the end of the 20th century, when it became apparent that the goat keeping had a prospect in our country, there has been a turnaround in legal policy. Timely, lifting the ban on keeping goats as well as ideal conditions for keeping goats give a bright perspective to goat production in Bosnia and Herzegovina.

References

FAO (2015). *Statistics Division*, Roma.

Mioč B. & Prpić Z. (2011). *Isplativost uzgoja koza*. Gospodarski list dd, Zagreb.

Službeni list Narodne Republike Bosne i Hercegovine (1947). *Uredba o zabrani držanja koza*. Broj 57, 31. decembar 1947. godine.

Službeni list Narodne Republike Bosne i Hercegovine (1948). *Naredba o vremenu sprovođenja zabrane držanja koza u pojedninim krajevima.* Broj 4, 20. januar 1948. godine.

Službeni list Narodne Republike Bosne i Hercegovine (1948). *Naredba o izmjeni i dopuni naredbe o vremenu sprovođenja zabrane držanja koza u pojedinim krajevim*a. Broj 14, 2. april 1948. godine.

Službeni list Socijalističke Republike Bosne i Hercegovine (1965). *Zakon o zabrani držanja koza.* Broj 6, 28. januar 1965. godine.

Službeni list Socijalističke Republike Bosne i Hercegovine (1982). *Ukaz o proglašenju zakona o izmjenama i dopunama zakona o zabrni držanja koza.* Broj 16, 31. maj 1982. godine.

Službeni list Republike Srpske (1997). *Zakon o prestanku važenja zakona o zabrani držanja koza*. Broj 3, 14. februara 1997. godine.

Šakić V., Katica V. & Ferizbegović J. (2011). *Uzgoj koza*. Univerzitet u Sarajevu, Veterinarski fakultet, Sarajevo.

Važić B., Drinić M. & Savić N. (2016). *Kozarstvo*. Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka.

Kozarstvo njegova stagnacija i razvoj na području Bosne i Hercegovine

Božo Važić[1], Sara Popadić[1], Biljana Rogić[1], Vesna Gantner[2]

[1]*Univerzitet u Banjoj Luci, Poljoprivredni fakultet, Banja Luka, Republika Srpska*
[2]*Agrobiotehnološki fakultet Osijek, Univerzitet Josipa Juraja Strosmajera, Osijek, Hrvatska*

Autor za korespondenciju: Božo Važić, bozo.vazic@agro.unibl.org

Sažetak

Zahvaljujući velikim prirodnim sposobnostima adaptacije na uslove držanja i ishrane, koze se danas uspješno gaje u svim dijelovima svijeta, uključujući aridna, suptropska, tropska, planinska i ravničarska područja. Danas se u svijetu gaji oko 1 milijarde koza. Od osamdesetih godina prošlog vijeka do današnjih dana broj koza u svijetu se skoro uduplao. Kao životinjska vrsta uspješno podnosi sve sisteme proizvodnje. U Bosni i Hercegovini neposredno pred dolazak Austrougarske monarhije gajilo se oko 1 500 000 koza, a neposredno pred početak Drugog svjetskog rata oko 500.000. Tendencija smanjenja broja koza zabilježena je u toku Drugog svjetskog rata, a posebno poslije rata i donošenja zakona kojim je zabranjeno držanje koza. Cilj ovoga rada jeste sagledavanje stagnacije razvoja kozarstva u Bosni i Hercegovini, koje je pratilo donošenje zakonskih rješenja i njihovoj zabrani držanja. Prema spomenutim zakonskim rješenjima zabranjeno je držanje balkanske rase koza, ali je dozvoljeno držanje plemenitih rasa, posebno sanske koze pod određenim uslovima. Danas u Bosni i Hercegovini imamo između 50 000 i 60 000 koza, što je mali broj ako se uzme važnost njenih proizvoda za ljudsku ishranu.

Ključne riječi: koza, stagnacija, zakonska rješenja, Bosna i Hercegovina

Professional paper

Households as a main factor of rural and sustainable development in the Republic of Serbia

Sreten Jelić, Tatjana Jovanović, Olga Gavrić

Faculty of agriculture, Nemanjina 6, Belgrade, Serbia

Corresponding author: Sreten Jelić, sjelic@agrif.bg.ac.rs

Abstract

The research is focused at households located in rural areas of Serbia, with special emphasis on the agriculture households. However, a tendency has been seen that some households are active in other economic branches such as rural tourism, artistry, trade, food industry, etc.
The Theoretical framework for socio-economic analysis is based on the Monographic method for qualitative and quantitative description of households, rural and sustainable development. As a complementary tool of the previously specified method the analysis of the documents, was used, such as official publications and statistical data (total number of households in other settlements in the Republic of Serbia). Research has shown the existence of an unquestionable role of households, primarily in rural and sustainable development. Accordingly, 17 objectives of sustainable development are observed in the function of solving the challenges faced by households as the holders of rural development.

Key words: households, rural development, sustainable development, social changes, rural areas

Introduction

Serbia has 7.18 million inhabitants, out of which 40.60% live in rural areas. In relation to the total number of households, 2,487,886, we have 631,000 farms. Households have significant potential for the development of rural areas, which includes the development of agriculture and some other activities. Namely, our country has 5.2 million hectares of agricultural land, of

which 4.2 million hectares is arable land, but about 3.35 million hectares are processed, while other areas, we can say, are neglected and not used.

The limiting factor is inherited ownership structure of farms, because small-scale fragmented properties prevail. More and more aging and single member farms are working in agriculture, and can not be important subjects of development unless adequate measures and enforceable agricultural policies are implemented, where the development strategy would be realistic, achievable and sustainable.

In rural areas of Serbia, according to the activities, most of the households are predominantly engaged in agriculture, but there are other activities, such as rural tourism, crafts, trade and food industry. Bearing in mind all the specifics of rural areas, the role of households in their development is indisputable.

However, the scarcity of natural resources and the degradation of the environment point to the increasing importance of sustainable development. The achievement of sustainability goals ensures the resolution of rural development challenges on the one hand, as well as the creation of an incentive environment for households on the other.

In the first part of the paper, the concepts of rural and sustainable development are analyzed, as well as the most important characteristics of households as the main holders of agriculture. The second part of the paper points to the specificity of the relationship between households as bearers of rural and sustainable development.

Material and Methods

The theoretical framework for socio-economic analysis is based on a monographic method for the qualitative and quantitative descriptions of households, rural and sustainable development. As a complementary tool to the above-mentioned method was used the analysis of documents, as well as official publications and statistical data of the Statistical Office of the Republic of Serbia.

The aim of this paper is to look at households located in rural areas of Serbia, with a special emphasis on the part dealing with agriculture. In addition to this primary goal, the secondary goal was to present tendencies that are increasingly expressed in terms of the fact that household members choose other branches, such as rural tourism, crafts, trade, food industry, etc. for their activities.

The subject of research is the development potentials of households as the main subjects of rural and sustainable development.

Resultat and Duscussion

Conceptual definition of rural areas and rural development

Rural areas have been for many years, almost decennial, subject of interest and analysis in accordance with the methodology of explaining concepts that are rather razed and uneven. In this way, rural areas can be defined in several ways in relation to different principles and aspects of observation. Bearing in mind this, it is not surprising that there is no universal internationally recognized definition of what are actually rural areas. One of the conceptual determinations is that "rural areas are areas where the basic human activity is agriculture, where the survival of people is directly related to it, and so called, primary sector, partly, as well as the exploitation of forests, by another, the smaller part" (Jelić & Jovanović, 2018).

Rural areas in Serbia are defined as a space that represents the "rest" outside the urban area. In accordance with this definition, about 70% of the territory of Serbia can be classified as a rural area, in which live 43% of the total population. However, this definition is not recognizable from the point of view of the European Union (EU). In order to allow comparison with EU statistics, rural areas in Serbia, according to the criteria of the Organization for Economic Co-operation and Development (OECD), are defined as areas with a population density of less than 150 inhabitants per km². According to this definition, 85% of the territory of Serbia belongs to the so called rural areas, with almost 55% of the total population. In rural areas, besides significant human resources, there are most of the country's natural resources (agricultural land, forests, water), rich ecosystems and biodiversity, as well as economic activities, cultural and historical heritage (Milić, 2011).

It is nothing different when it comes to the concept of rurality. In that sense, individual countries set their own criteria for defining rural areas by highlighting national specificities and their own rural development issues.

Thus, we come to the question of what is rural, and what does not, as well as what elements essentially reflect and characterize "rurality". Rurality is a complex and specific whole of social relations within the rural space. It refers to space, organization, arrangement, relations in that area, which directly and indirectly shape the rural way of life.

At first, rural areas were perceived as "something else" from urban centers. Today's definitions getting out from the narrow territorial framework of the understanding of rural areas, extending it to an economic and social component. As such, this area includes villages, small towns and regional centers. The most commonly used criteria in defining the rural area are the population density and the number of inhabitants in a settlement.

Considering the complexity of rural development, this term is often equated with the process of improving the quality of life and economic well-being of people living in relatively isolated, poorly populated, "non-urban areas" (Bogdanov, 2015). In many countries, rural development is still equating with the growth of agriculture, leaving aside the parallel process of marginalization of villages and the agricultural sector.

A modern approach to rural development puts in the forefront the definition of efficient mechanisms to ensure coordination of the development of agriculture and other activities in rural areas in accordance with the principles of sustainable development, in order to improve the living standard and quality of life of the population (Bogdanov, 2007). All this leads to studies that take into account spatial differences, not neglecting the economic, social and environmental issues of rural development. Only in this way can it go in step with the growing changes in the narrower rural and wider social sense.

Of course, all these approaches and interpretations of rurality and rural development are in close correlation with the changes that accompany global development trends.

The European Union defines rural development as a multifunctional concept in which rural development, in relation to the general social developement, has a fourfold role: economic, ecological, cultural and sociological.

The economic role of rural areas is expressed through the provision of food and other raw materials of agricultural origin for the growing needs of the population and the achievement of competitive income. Known term of the peasant economy, which is a socially regulated system of family farms, in which production in family farms is the dominant type of production.

The ecological role of rural areas is exhausted through the possibility of sustainable management of natural resources (land, water, forests), that is, conservation of nature and living environment, which is a basic feature of sustainability.

The cultural community through the specificity of the cultural framework marks the cultural dimension. The characteristics of a particular rural community are specific, often they can not be compared and can not be considered a representative of the broader social units - the entire rural society. The cultural heritage of rural areas is very rich and has a wider, national and international significance. The cultural aspect of rural development is becoming increasingly

important when it comes to defining the economic potentials of rural areas and rural communities.

The sociological dimension of rural areas is a special type of social system in which people feel deeper and closer to other members and recognize the area as a place of shared concern and action. This system is long lasting, has continuity and is expected to survive. Community activities depend on cooperation / volunteering with minimal use of sanctions or coercion. The system is multifunctional. It is expected that he realized products / services and to comply with the many dimensions of interaction (Milić, 2011).

Defining a new rural development policy must be in line with the guiding principles and sustainable development standards. The concept of sustainable development has always been a topical theme that implies the balancing of three elements: 1) economic (sustainable models of production and consumption), 2) environmental element (maintenance and restoration of healthy ecosystems), and 3) social (total eradication of poverty and sustainable social systems).

Potentials of households in the function of rural development

One of the most important pillars in understanding and defining the entire rural development policy is certainly the improvement and prospects of households, specifically rural households. In this paper, we have especially focused on rural households, which represent the basic factor for the improvement and development of agriculture and rural development, since they are in large percentage represented in the structure of rural areas in Serbia.

According to the Statistical Office of the Republic of Serbia, any family or other community of persons who together reside and spend their own income together to settle basic living needs (housing, food, etc.) is considered, regardless of whether all members are permanently in the place where an household is inhabited or some of them stay for a longer period in another settlement, or a foreign country, for work, education or for other reasons.

The most commonly used is the classification of rural households in households with farms and other households with agricultural potentials considered as holdings. Households are divided according to sources of income for agricultural, mixed and non-agricultural.

Households with agricultural farmstead are any household that uses at least 10 acres of arable land, as well as a household with less than 10 acres of arable land if it has: - at least one cow and calf, or - one cow and a steer, or - one cow and two adult throats of small cattle of the same species, or - five adult sheep, or - three adult pigs, or - four adult heads of sheep and pigs together, or - fifty pieces of adult livestock, or - twenty beehives of bees. The above criteria

apply to all households, regardless of whether they are housed in urban or "other" settlements, and regardless of where the land, cattle, livestock or bee hives are located, for which the household has provided data. Agricultural farmsteads are those farms in which all income comes from individual farmers in the holding. Non-agricultural farmsteads are those farms in which the income comes from a member, that is, from members of the household who perform non-agricultural professions or perform some agricultural activity outside of their own or family farm, or, in other words, income arises from a pension, from other property, social assistance or some other type permanent income.

Mixed farms are those that simultaneously realize revenues that characterize agricultural and income that are characteristic of non-agricultural farmstead. Non-income households are holdings in which an unknown source of income or income is derived from supporters (including legal entities) who are not members of the holding (Bogdanov, 2007).

According to the Census of Population, Households and Dwellings from 2011, in rural areas of Serbia, there are 954,020 households, which is 38,35% of the total number of households in Serbia. Observed by sources of income, the largest number of households (35.10%) in rural areas of Serbia generates mixed income.

Next comes the income from pension (29.44%), and revenues from non-agricultural production (18.85%). Interestingly, only agricultural income comes from (6.57%) households in rural areas (Table 1).

The number of household members decreased, so that households with one and two members (46.86%) dominate today with respect to the total number of households in rural areas.

Based on the structure of households by source of income and the number of household members shown in Table 1, we can conclude that households with one and two members are predominantly elderly households, since most of them earn their income from pension (for single-member households 62.95%, while in two-member households, this percentage amounts to 49.02%). With the increase in the number of household members (3, 4, 5, 6 and more), there is a decline in the number of those with whome are the main source of income are pensions (from 13.00% in three-member, to 2.53% in six-member households).

Table 1. Household structure according to the number of members and sources of income, by type of settlement in Serbia, 2011

Serbia / type of settlement		Total	%	Sources of household income						
				In agriculture	In non-agriculture	Pensions	Social benefits	Other types of income	Mixed income	No income
Serbia		2.487.886	100	2,74	29,96	28,81	1,9	4,37	29,51	2,74
Number of household members	1	555.467	22,33	0,63	4,46	13,22	0,54	1,57	0,32	1,58
	2	638.091	25,65	0,74	5,34	11,98	0,36	1,02	5,6	0,61
	3	476.642	19,16	0,49	7,75	2,37	0,29	0,75	7,2	0,30
	4	454.127	18,25	0,45	9,64	0,75	0,34	0,65	6,36	0,17
	5	197.506	7,94	0,21	2,05	0,29	0,19	0,21	4,94	0,06
	6 and more	166.053	6,67	0,22	0,84	0,19	0,17	0,14	5,09	0,02
City settlements		1.533.886	61,65	0,22	22,73	17,52	0,96	2,43	16,05	1,73
Number of household members	1	350.052	14,07	0,06	3,67	8,03	0,24	0,90	0,18	1,00
	2	396.450	15,93	0,05	4,22	7,23	0,19	0,54	3,30	0,40
	3	318.151	12,79	0,04	6,01	1,54	0,17	0,44	4,39	0,20
	4	295.790	11,89	0,05	7,02	0,47	0,18	0,33	3,67	0,10
	5	105.726	4,25	0,01	1,35	0,19	0,09	0,10	2,52	0,02
	6 and more	67.697	2,72	0,01	0,45	0,09	0,09	0,07	1,99	0,01
Other settlements		954.020	38,35	2,52	7,23	11,29	0,94	1,91	13,46	1,01
Number of household members	1	205.415	8,26	0,57	0,79	5,20	0,31	0,67	0,14	0,60
	2	241.641	9,71	0,68	1,12	4,76	0,17	0,48	2,3	0,20
	3	158.491	6,38	0,45	1,74	0,83	0,12	0,31	2,8	0,11
	4	158.337	6,34	0,41	2,50	0,27	0,16	0,28	2,68	0,07
	5	91.780	3,70	0,20	0,69	0,13	0,10	0,10	2,45	0,02
	6 and more	98.356	3,96	0,21	0,39	0,10	0,08	0,07	3,09	0,01

Source: Census of Population, Households and Dwellings, SORS, pp. 70-71

Sustainable development-concept and characteristics

Climate change, the rising pressure of the population, and the limitations of natural resources have made sustainable growth one of the dominant developmental paradigms of the 21st century. There are several definitions of sustainability in the literature, with the highest priority being the definition of the Brundland Commission in 1987, according to which sustainable development is the one that meets the needs of the present, without compromising the ability of future generations to undermine their own needs (Jovanović & Gavrilović, 2008).

Sustainable development is a prerequisite but also the ultimate goal of effectively organizing human activities on the Earth (Pešić, 2012). As such, we consider it as a multidimensional

concept that implies the coherence of the social, economic and environmental aspects. In other words, in order to achieve long-term sustainability, it is necessary to combine economic, social and environmental goals. The most common economic goals are to achieve economic growth with low inflation and low indebtedness of the country. Social goals emphasize the increase of social capital through the reduction of poverty, inequality of sexes and other irregularities. Finally, environmental goals are based on efficient resource management and environmental protection.

Over the years, the significance of some of the goals of sustainable development has changed. Namely, in the beginning, the focus was on the untapped consumption of society. Today, primates take environmental objectives in the context of resources and their use from the point of view of future production capabilities and sustainable yields.

UNDP (United Nations Development Program) defines and specifies 17 global objectives of sustainable development, which we state, Table 2.

These goals came into force in January 2016 and represent a kind of inclusive agenda. All goals are interconnected since the key to the success of one goal often lies in looking at challenges that are inherent in some other objective. Consequently, all three dimensions of sustainability are balanced. Also, UNDP's Global Sustainability Objectives provide a guideline and framework for integration and implementation as part of national development programs.

Bearing all this in mind, the implementation of the sustainability concept requires a strategic and iterative approach where, through coordination of activities and resources, we achieve defined goals. In the process itself, the role of the state and state institutions is indispensable, as well as the change of the existing visions of micro and macro entities.

Table 2. Global objectives of sustainable development

1. A world without poverty	10. Reducing Inequality
2. A world without hunger	11. Sustainable Cities and Communities
3. Good health	12. Responsible consumption and production
4. Quality education	13. Climate action
5. Gender equality	14. Life under water
6. Clean water and sanitation	15. Life on earth
7. Available and renewable energy	16. Peace, justice and strong institutions
8. Dignified work and economic growth	17. Partnership to goals
9. Industry, innovation and infrastructure	

Source: http://www.rs.undp.org

Usually in practice, there is a lack of concrete results and progress in implementing the concept of sustainability. The reason lies in the fact that there are some limitations that are the main obstacle to achieving these goals (Homberg, 2009). The constraints are generally the result of several factors, such as: (1) neglecting the time dimension, (2) misunderstanding of the concept itself, (3) lack of commitment and cooperation, and (4) the existence of so-called sustainable sustainability.

Specificity of the relationship between households, rural and sustainable development

After defining households as bearers of rural and economic development, it is necessary to consider the characteristics of the given link. Namely, the theoretical concept of rural development points the importance of agrarian policy. In particular, the large migratory pressure and the movement of the rural population into urban areas led to significant social, economic and political barriers that required the need for rural development policies. Despite the fact that different policies are needed for rural regions of different levels of development, there are objectives that are unique and inherent in all rural development policies (Bogdanov, 2015):

1. Increasing the competitiveness of rural areas, so that they can contribute in an adequate way to the economic development of the entire economy.
2. Ensuring a satisfactory living standard for the rural population.
3. Protection and sustainable use of natural resources and rural environment, especially where they can be over-exploited as a result of different market and economic activities.

   Bearing in mind the specificities of sustainable development, we realize that the goals of rural and sustainable development are mutually compatible and coherent. Finding comparative advantages and putting them in the function of long-term sustainable development is a challenge, and the well-designed rural strategy of a rural community is a good basis for the sustainable development of the society as a whole (Mirković, 2011). In other words, rural development is just one of the segments that are common to the economic, ecological and social dimension of sustainability. Consequently, the improvement of competitiveness, environmental protection and land management, as well as economic diversification and quality of life, have been singled out as common goals of sustainable and rural development. One of the best examples of unifying the given goals is the definition of the concept of sustainable agriculture, which was created in response to the growing devastation of agricultural resources, which it comes as a result of more and more intensive

production technology (Bogdanov, 2015). Many sustainable development goals have served as a benchmark for defining concrete indicators on the basis of which we monitor the achievement of rural development.

On the other hand, households present the basic subjects of rural and economic development of the economy, and accordingly they can be considered as bearers of sustainable development. Viewed from the vision of households, the implementation of the principles of sustainable development and consequently achievement of the goals of rural development is very significant, since it creates an adequate environment for the prosperity of the same. Accordingly, the mentioned link has a two-way character that ultimately contributes to convergence economic and ecological goals, which were often diametrically different. Rural policy as part of the agricultural policy improves the competitiveness of local communities by stimulating local production, old crafts, preserving cultural heritage, in order to increase their own revenues and reduce certain costs and losses that result from the application of environmental measures (Mirković, 2011). Institutional support of the state in the form of relevant policies and strategies is necessary, after the harmonization of the objectives of rural and sustainable development. The listed characteristics have immanent importance for the countries in which agriculture is the main economic branch, such as Republic of Serbia.

Conclusion

In this paper, some features of households (number of members and source of income) are analyzed, where there is evident decrease in the number of members, so we have more and more households with one and two members, mostly old ones. It is obvious that households and farmsteads are affected by the processes of change, which have resulted from structural changes in the population, which affects the development of rural areas, rural development, development of agriculture and other activities, and hence the development of the economy as a whole and sustainable development.

With the potentials of households, ie farms that have larger land area, labor, machinery, livestock, etc. it is possible to increase agricultural production, which would create opportunities for development of rural areas and sustainable development.

According to the latest data of the Statistical Office of the Republic of Serbia from 2017, the most significant share in GDP formation has the manufacturing sector 15.1%, while

agriculture, forestry and fisheries has 6.0%. On the other hand, the share of expenditures for personal consumption of households is 69.6%.

By activity, in 2017, in the manufacturing sector, the real growth of gross value added was 4.8%, in sectors of service, accommodation and food, 10.8%, while the real decline in gross value added in the agriculture, forestry and fisheries was 11.2%.

Accordingly, it is necessary to create preconditions for the development of comparative advantages of agriculture or other activities for which there are conditions where households or farms would be the primary bearers of the development of rural areas, rural development and sustainable development.

Namely, one way of promoting and developing rural areas is to encourage sustainable development and create new employment opportunities, especially for young people and women, as well as the implementation of the latest information technology solutions. In this sense, one of the important goals of the agrarian policy is also the diversification of farm activities to non-agricultural activities and services and the strengthening of links between agriculture and other sectors of the economy.

It turned out that today's challenges, posed by globalization and climate change, can adequately respond an integrated approach in defining rural policies, which will be in the function of long-term sustainable development.

References

Bogdanov, N. (2015). *Ruralni razvoj i ruralna politika*. Poljoprivredni fakultet, Univerzitet u Beogradu

Bogdanov, N. (2007). *Mala ruralna domaćinstva u Srbiji i ruralna nepoljoprivredna ekonomija*. UNDP.

Homerg, J. (2009). Put ka održivom razvoju, *Održivi razvoj Srbije naša zajednička budućnost-nacionalna strategija održivog razvoja,* Ministatsrvo za nauku i tehnološki razvoj, 12-22.

Jelić, S. & Jovanović, T. (2018). *Selo u vrtlogu promena*. Poljoprivredni fakultet Univerziteta u Beogradu.

Jovanović-Gavrilović, B. (2006). *Održivi razvoj-suština koncepta i mogućnost merenja*. Održivi razvoj u SCG. Institucionalno prilagođavanje rešenjima i praksi u EU (tematski zbornik), Ekonomski fakultet, 51-71.

Milić, B. (2011). *Ruralni razvoj-praktikum za lokalne aktere*. SKGO, Beograd.

Mirković, D. (2011). *Održiva poljoprivreda, putokaz ka održivom razvoju*. Ministarstvo za nauku i tehnološki razvoj, 416-428.

Pešić, R. (2012). *Ekonomika životne sredine i prirodnih resursa*. Poljoprivredni fakultet, Beograd.

Popis stanovništva, domaćinstava i stanova 2011. u Republici Srbiji (2013). *Stanovništvo, domaćinstva prema broju članova, podaci po naseljima.* Republički zavod za statistiku, Knjiga 10, Beograd.

Republički zavod za statistiku, *www.rzs.rs*, pristupljeno: 08. 05. 2019.

United nations development programme, http://www.rs.undp.org/content/serbia/sr/home/ sustainable-development-goals.html, pristupljeno: 08. 05. 2019.

VIII INTERNATIONAL SYMPOSIUM ON AGRICULTURAL SCIENCES

AGRORES 2019

is supported by

EPC
Електропривреда Републике Српске

HET
ZP „Hidroelektrane na Trebišnjici" a.d. Trebinje

Град Требиње

Министарство пољопривреде, шумарства и водопривреде

Министарство за научно технолошки развој, високо образовање и информационо друштво

POPOVO POLJE

SWG RRD

UNDP
Empowered lives.
Resilient nations.

FARMAVIT

syngenta
Syngenta Agro d.o.o
Predstavništvo u BiH, Gradiška

Удружење виноградара и винара источне Херцеговине „Винос“

Agrimatco

PAĐENI
MLJEKARA BILEĆA

MIRIS HERCEGOVINE
http://www.mirishercegovine.com

ANĐELIĆ
ORGANIC PRODUCTS
Essential Oils, Dried Herbs, Spices, Liquid Extracts

EKOLOŠKO GAZDINSTVO VLAČIĆ Trebinje

Herzeg House organic store

nature Line

ALF-OM

DARKO Komerc

farmofit
FSH "RAPIĆ" GRADIŠKA