PROCEEDINGS

Natural resources green technology & sustainable development /2

5th-7th October 2016, Zagreb, Croatia

Published by:
Faculty of Food Technology and Biotechnology, University of Zagreb, Croatia

Editors:
Ivana Radojčić Redovniković
Višnja Gaurina Srček
Kristina Radošević
Tamara Jakovljević
Renata Stojaković
Dina Erdec Hendrih

Cover&logo design: Hendrih Feldbauer d.o.o.

Printed by: Hendrih Feldbauer d.o.o.

Text prepared by: The information provided in the Proceeding is based on the submitted abstracts of conference participants. Authors are fully responsible for the text and its quality. Language corrections were not made.

ISBN 978-953-6893-08-9

A CIP catalogue record for this book is avaliable from the National and University Library in Zagreb under 000942980.

Organized by
Croatian Forest Research Institute
Faculty of Food Technology and Biotechnology, University of Zagreb
Faculty of Forestry, University of Zagreb
Institute for Adriatic Crops and Karst Reclamation
Croatian Society of Biotechnology
Academy of Forestry Sciences

Supported by
International Union of Forest Research Organizations, Division 9 - Forest Products (IUFRO)
European Forest Institute (EFI)
European Biotechnology Thematic Network Association (EBTNA)

Under the auspices of
Kolinda Grabar - Kitarović, President of the Republic of Croatia
Ministry of Science, Education and Sports
Ministry of Agriculture
Ministry of Environmental and Nature Protection
University of Zagreb
Croatian Environment and Nature Agency
Croatian Chamber of Forestry and Wood Processing Engineers
Croatian Science Foundation - Project EFFEctivity
Croatian Chamber of Economy
Croatian Academy of Sciences and Arts
Zagreb County
City of Jastrebarsko

Chair of the Conference
Dijana Vuletić, Croatia

Organization committee
Chair: Ivana Radojčić Redovniković, Croatia
Co-chair: Tamara Jakovljević, Croatia

Members
Damir Ježek, Croatia
Vladimir Jambreković, Croatia
Renata Pernar, Croatia
Lukrecija Butorac, Croatia
Vesna Zehner-Krpan, Croatia
Igor Anić, Croatia
Jadranka Frece, Croatia
Kristina Radošević, Croatia
Marina Cvjetko Bubalo, Croatia
Jasna Halambek, Croatia
Marija Gradečki-Poštenjak, Croatia
Hrvoje Marjanović, Croatia
Elvis Paladinić, Croatia
Sanja Perić, Croatia
Silvija Krajter Ostojić, Croatia
Ivan Seletković, Croatia
Željko Zgrablić, Croatia
Dinka Matošević, Croatia
Slobodan Miko, Croatia
Natalija Velić, Croatia
Ivan Balenović, Croatia
Maša Zorana Ostrogović Sever, Croatia
Jasnica Medak, Croatia

International Scientific Committee
Chair: Tamara Jakovljević, Croatia
Co-chair: Ivana Radojčić Redovniković, Croatia

Members
Giancarlo Cravotto, Italy
Mersudin Avdibegović, Bosnia & Herzegovina
François Lefevre, France
Daniel Kracher, Austria
Alessandra De Marco, Italy
Slađana Šobajić, Serbia
Zoltán Barcza, Hungary
Anikó Kern, Hungary
Aleksandra Sander, Croatia
Stela Jokić, Croatia
Mladen Brnčić, Croatia
Tonči Rezić, Croatia
Anita Slavica, Croatia
Višnja Gaurina Srček, Croatia
Verica Dragović-Uzelac, Croatia
Karin Kovačević Ganić, Croatia
Suzana Rimac Brnčić, Croatia
Nenad Potočić, Croatia
Tomislav Dubravac, Croatia
Milan Pernek, Croatia
Mladen Ivanković, Croatia
Danko Diminić, Croatia
Jura Čavlović, Croatia
Goran Jelić, Croatia

Confrence Secretary:
Renata Stojaković
GREEN2016@sumins.hr

Sponsors
Croatian Chamber of Forestry and Wood Processing Engineers
Zagreb County
Zagreb County Tourist Board
Gorea Ltd.
FeraVina Ltd.
Zigante tartufi
Karlić tartufi - GIR Ltd.
Karbun - Karbun - Production of Charcoal and Firewood

Exhibitors
Kefo Ltd.
Crux Ltd.
Labeko Ltd.
UTP Ltd.
Ansar-analitika Ltd.
KemoLab Ltd.
AlphaChrom Ltd.

Acknowledgement to reviewers

The Editors of the Proceedings of NATURAL RESOURCES, GREEN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT-GREEN/2 the extend their deepest gratitude to the following manuscript reviewers who maintained the professional standards of our Proceedings:

Tamara Jakovljević, Ivana Radojčić Redovniković, Croatia Giancarlo Cravotto, Mersudin Avdibegović, François Lefevre, Daniel Kracher, Austria Alessandra De Marco, Slađana Šobajić, Zoltán Barcza, Anikó Kern, Aleksandra Sander, Stela Jokić, Mladen Brnčić, Tonči Rezić, Anita Slavica, Višnja Gaurina Srček, Verica Dragović-Uzelac, Karin Kovačević Ganić, Suzana Rimac Brnčić, Nenad Potočić, Tomislav Dubravac, Milan Pernek, Mladen Ivanković, Danko Diminić, Jura Čavlović, Goran Jelić

MINERAL COMPOSITION AND HEAVY METALS CONTENT OF SWEET CHESTNUT FRUITS IN FIVE NATURAL POPULATIONS FROM CENTRAL CROATIA

*Igor Poljak[1], Nada Vahčić[2], Milica Gačić[2], Marin Ježić[3], Mirna Ćurković-Perica[3], Marilena Idžojtić[1]**

[1]University of Zagreb Faculty of Forestry, Svetošimunska 25, HR-10000 Zagreb, Croatia

[2]University of Zagreb Faculty of Food Technology and Biotechnology, Pierottijeva 6, HR-10000 Zagreb, Croatia

[3]University of Zagreb Faculty of Science, Marulićev trg 9a, HR-10000 Zagreb, Croatia

**Address and email of corresponding author: University of Zagreb Faculty of Forestry, Svetošimunska 25, HR-10000 Zagreb, Croatia; E-mail: idzojtic@sumfak.hr*

Introduction

The sweet chestnut (*Castanea sativa* Mill.) is a noble hardwood providing multiple economic benefits (wood, fruit, honey, tannin, preservation of ecological and landscape values). It is distributed in the Mediterranean region, where chestnut forests spread over an area of 2,530,000 ha (Conedera *et al*. 2004). In Croatia, the sweet chestnut grows in the forests of the colline belt of the continental part, in Istria and on the islands of Krk and Cres. The largest part of the range of the sweet chestnut extends through central Croatia, from the Slovenian border to the border with Bosnia and Herzegovina (Medak *et al*. 2009).

Chestnut fruits are an important food in many European countries. In recent years, the consumers have been showing an increased interest in chestnut fruits because of their nutritional qualities and potential beneficial health effects (Barreira *et al*. 2012). Chestnuts are rich in carbohydrates and are a good source of essential fatty acids and minerals (Borges *et al*. 2008; Barreira *et al*. 2009; De Vasconcelos *et al*. 2010). Many studies about the nutritional composition of chestnut define them as fruit which, in contrast to the most other nuts, have high water content, contain small quantities of fat and oil and are cholesterol free (De La Montaña Míguelez 2004; Borges et al. 2007, 2008; Peña-Méndez *et al*. 2008; Barreira *et al*. 2009, 2012). They also contain high quality protein and are gluten free. Except of that, they are good source of vitamin C, B1, B2, and folates, as well as appreciable levels of fibre (De Vasconcelos *et al*. 2010). Breisch (1995) indicated that the main macroelements are potassium, phosphorus, calcium and magnesium.

Material and Methods

Sweet chestnut fruits were collected during October 2007 in five natural populations in Croatia, as shown in Figure 1. Fruits were collected from five different trees per each population. Directly after collection, the freshly picked fruits were peeled. The pericarp and seed coat were removed, after which only the edible part of the fruit remained, i.e. the kernel. The cleaned seeds were shredded using a shredding blender. From each tree, 100 g of shredded sample was placed in hermetically closed containers and stored in a freezer at -20 °C. Macro and micronutrients (K, Ca, Mg, Na, Fe and Zn) and toxic metals (Pb, Cd, Hg, As) were determined by atomic absorption spectrometry using a Varian SpectrAA 220 device.

For all of the studied variables, descriptive statistical parameters were calculated. Assumptions of normality were checked using the Shapiro-Wilk test, and the assumption of homogeneity of variance using Levene's test. Statistically significant differences between studied groups of trees were established using the analysis of variance (ANOVA). The differentiation among studied groups for variables (Hg, Cd) with a skewed and heteroscedastic distribution was verified using the Kruskal-Wallis ANOVA. The data used in the PC analysis were previously standardized using the z-score method. The specified statistical analyses were conducted using the STATISTICA 8.0 software.

Results and Discussion

The results of the descriptive statistical analysis are shown in Table 1. With regard to macronutrients, K (613.96 mg/100 g f.w.) was the most abundant, followed by Ca, 35.17 mg/100 g f.w.; Mg, 29.99 mg/100 g f.w.; and Na, 3.69 mg/100 g f.w. A similar pattern was observed by Bellini *et al*. (2007) and Poljak *et al*. (2016) for the Italian and Croatian chestnut cultivars. A smaller mass fraction of potassium and calcium was recorded in Spanish (Pereira-Lorenzo *et al*. 2006; Peña-Méndez *et al*. 2008) and Portuguese (Ferreira-Cardoso *et al*. 2005; Borges *et al*. 2008) chestnuts. Magnesium content on average is within the range reported by Pereira-Lorenzo *et al*. (2006) for Spanish chestnut cultivars. Smaller magnesium content on average is reported by Bellini *et al*. (2007) for the Italian chestnut cultivar 'Marrone del Mugello' and higher by Borges *et al*. (2008) and Ferreira-Cardoso *et al*. (2005) for Portuguese chestnut cultivars, and Peña-Méndez *et al*. (2008) for Spanish chestnut cultivars. The sodium content of the chestnuts from natural populations is within the range reported by Pereira-Lorenzo *et al*. (2006) and Peña-Méndez *et al*. (2008) for Spanish chestnut cultivars. Smaller sodium content on average is reported by Borges *et al*. (2008), Ferreira-Cardoso *et al*. (2005), and Bellini *et al*. (2007) for the Portuguese and Italian chestnut cultivars. The average mass fraction of zinc in the chestnut fruits from the natural populations is in line with the data published for sweet chestnut cultivars (Ferreira-Cardoso *et al*. 2005; Pereira-Lorenzo *et al*. 2006; Peña-Méndez *et al*. 2008; Bellini *et al*. 2007; Borges *et al*. 2008; Poljak *et al*. 2016). Iron content ranged between 1.29 mg/100 g f.w. in population Gvozd and 1.56 mg/100 g f.w. in population Ozalj, with 1.37 mg/100 g f.w. as a mean value. Smaller mass fractions of iron was reported by Peña-Méndez *et al*. (2008) and Pereira-Lorenzo *et al*. (2006) in Spanish chestnut cultivars, and greater by Borges *et al*. (2008) and Ferreira-Cardoso *et al*. (2005) in Portuguese chestnut cultivars. This study confirmed that chestnuts from natural populations are a good source of macro- and micronutrients. The content of detected toxic heavy metals was lower in all samples than the maximum allowed amounts for the sweet chestnut fruits, which indicates an unpolluted environment. The cadmium and mercury level in approximately 25 % of the samples was below the limit of detection (< 0.01 mg/kg). According to the results of the ANOVA (Table 1), the studied populations differed in the mass fraction of potassium (p<0.01) and magnesium (p<0.05). The differentiation in the mass fraction of calcium, sodium, iron, zinc and toxic metals was not statistically significant. The PC analysis for the six studied macro and microelements established that the first two principal components account for 74.5 % of the total variability (Figures 2 and 3). The first principal component, which accounts for 54.0 % of variability, separates the populations with high potassium content, which is highly positively correlated with it, from the populations with high iron and zinc content, which is highly negatively correlated with the same principal component. The second principal component participates in the overall variance with 32.2 % and is in highly negative correlation with the content of magnesium. In other words, the bottom side of the diagram contains populations with a higher portion of the magnesium than those on the upper side. The differences found among the populations in mineral composition may reflect genetic factors and environmental conditions.

References

1. J.C.M. Barreira, S. Casal, I.C.F.R. Ferreira, M.B.P.P. Oliveira, J.A. Pereira, Nutritional, fatty acid and triacylglycerol profiles of *Castanea sativa* Mill. cultivars: a compositional and chemometric approach, J. Agr. Food Chem. 57 (2009) 2836-2842.

2. J.C.M. Barreira, S. Casal, I.C.F.R. Ferreira, A.M. Peres, J.A. Pereira, Chemical characterization of chestnut cultivars from three consecutive years: Chemometrics and contribution for authentication, Food Chem. Toxicol. 50 (2012) 2311-2317.

3. E. Bellini, E. Giordani, C. Marinelli, B. Perucca, Marrone del Mugello PGI chestnut nutritional and organoleptic quality, Acta Hortic. 693 (2005) 97-102.

4. O. Borges, B. Gonçalves, J.L.S. Carvalho, P. Correia, A.P. Silva. Nutritional quality of chestnut (*Castanea sativa* Mill.) cultivars from Portugal, Food Chem. 106 (2008) 976-984.

5. O.P. Borges, J.S. Crvalho, P.R. Correia, A.P. Silva, Lipid and fatty acids profiles of *Castanea sativa* Mill. chestnuts of 17 native Portuguese cultivars, J. Food Compos. Anal. 20 (2007) 80-89.

6. H. Breisch, Harvesting, storage and processing of chestnuts in France and Italy, in: E. Antognozzi (Ed.), Proc. of Int. Congress on Chestnut, Spoleto, Italy, 1994, pp 429-436.

7. M. Conedera, C. Manetti, F. Giudici, E. Amorini, Distribution and economic potential of the sweet chestnut (*Castanea sativa* Mill.) in Europe, Ecol. Medit. 30 (2004) 179-193.

8. J. De La Montaña Míguelez, M. Míguez Bernárdez, J.M. Garcia Queijeiro, Composition of varieties of chestnuts from Galicia (Spain), Food Chem. 84 (2004) 401-404.

9. M.C.B.M. De Vasconcelos, R.N. Bennett, E.A.S. Rosa, J.V. Ferreira-Cardoso, Composition of European chestnut (*Castanea sativa* Mill.) and association with health effects: fresh and processed products, J. Sci. Food Agric. 90 (2010) 1578-1589.

10. J.V. Ferreira-Cardoso, J.M.G. Torres-Pereira, C.A. Sequeira, Effect of year and cultivar on chemical composition of chestnuts from northern Portugal, Acta Hortic. 693 (2005) 271-278.

11. J. Medak, M. Idžojtić, S. Novak-Agbaba, M. Ćurković-Perica, I. Mujić, I. Poljak, D. Juretić, Ž. Prgomet, Croatia, in: D. Avanzato (Ed.), Following chestnut footprints (*Castanea* spp.) - Cultivation and culture, folklore and history, traditions and use, Script Hortic. 9 (2009) 40-43.

12. E.M. Peña-Méndez, M. Hernández-Suárez, C. Díaz-Romero, E. Rodríguez-Rodríguez, Characterization of various chestnut cultivars by means of chemometrics approach, Food Chem. 107 (2008) 537-544.

13. S. Pereira-Lorenzo, A.M. Ramos-Cabrer, M.B. Díaz-Hernández, M. Ciordia-Ara, D. Ríos-Mesa, Chemical composition of chestnut cultivars from Spain, Sci. Hortic. 107 (2006) 306-314.

14. I. Poljak, N. Vahčić, M. Gačić, M. Idžojtić, Morphological characterization and chemical composition of fruits of the traditional Croatian chestnut variety 'Lovran Marron', Food Technol. Biotechnol. 54 (2016) 189-199.

15. STATISTICA (Data Analysis Software System), v. 8.0, StatSoft, Inc, Tulsa, USA; 2001.

Table 1. Descriptive statistical parameters, and level of significance.

Minerals and toxic metals	Population					*P*
	Ozalj	Moslavačka gora	Vojnić	Gvozd	Topusko	
K mg/100 g f.w.	602,58±36,67	579,18±20,54	632,07±23,74	629,95±10,05	626,02±21,01	< 0.01
Ca mg/100 g f.w.	37,04±5,68	39,21±3,74	32,42±5,15	34,67±4,73	32,49±2,63	ns
Mg mg/100 g f.w.	26,67±1,47	32,80±5,07	28,07±3,03	34,44±5,61	27,98±4,52	< 0.05
Na mg/100 g f.w.	4,70±2,80	3,92±1,60	3,96±1,99	3,90±2,37	1,98±0,35	ns
Fe mg/100 g f.w.	1,56±0,30	1,35±0,16	1,33±0,23	1,29±0,24	1,30±0,20	ns
Zn mg/100 g f.w.	0,87±0,24	0,69±0,12	0,67±0,21	0,59±0,08	0,69±0,19	ns
Pb mg/kg f.w.	0,048±0,016	0,044±0,032	0,053±0,029	0,039±0,016	0,037±0,009	ns
Cd mg/kg f.w.	0,018±0,006	0,014±0,004	0,019±0,003	0,017±0,008	0,022±0,008	ns
Hg mg/kg f.w.	0,013±0,005	0,034±0,018	0,040±0,008	0,010±0,000	0,016±0,005	ns
As mg/kg f.w.	0,034±0,005	0,034±0,009	0,032±0,015	0,018±0,008	0,032±0,004	ns

f.w. – fresh weight

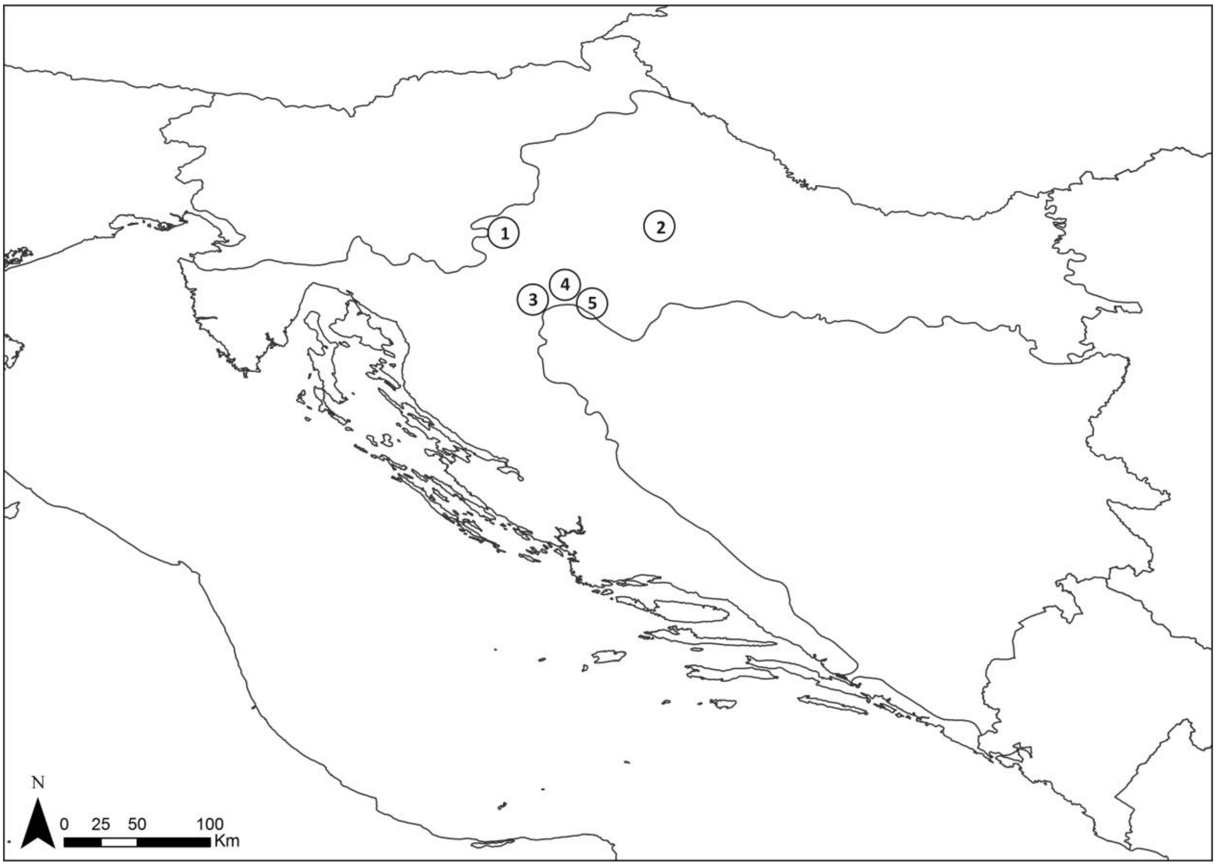

Figure 1. Sampled populations: (1) Ozalj; (2) Moslavačka gora; (3) Vojnić; (4) Gvozd; (5) Topusko.

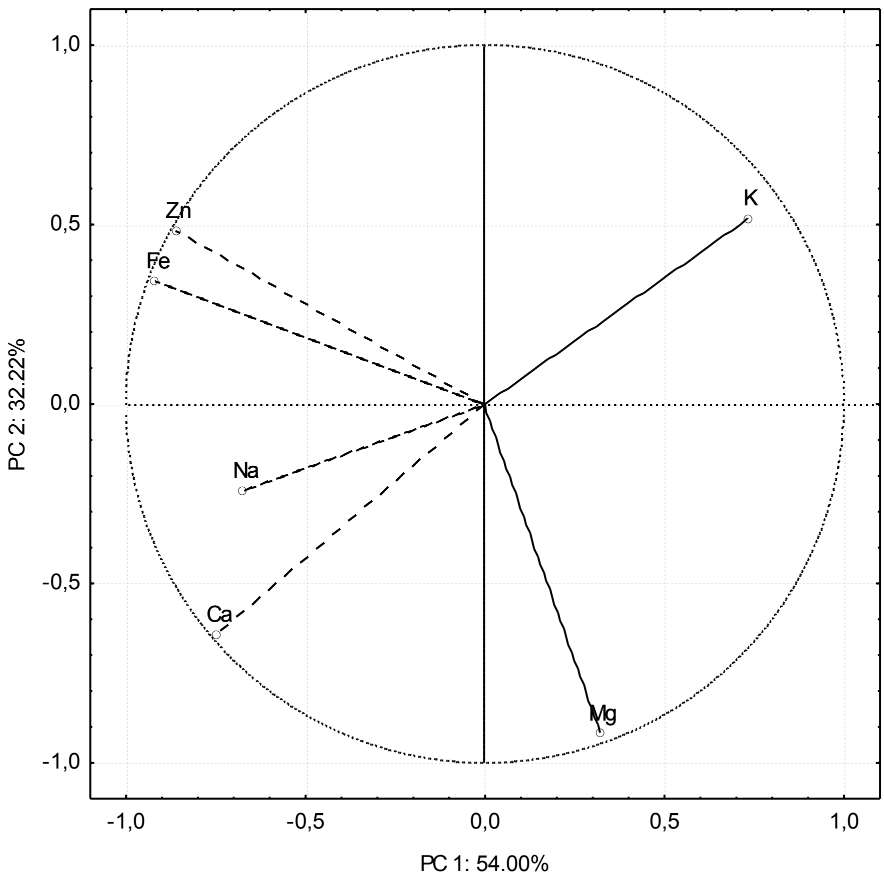

Figure 2. Score plot of the variables projected on the space of PC1 vs. PC2.

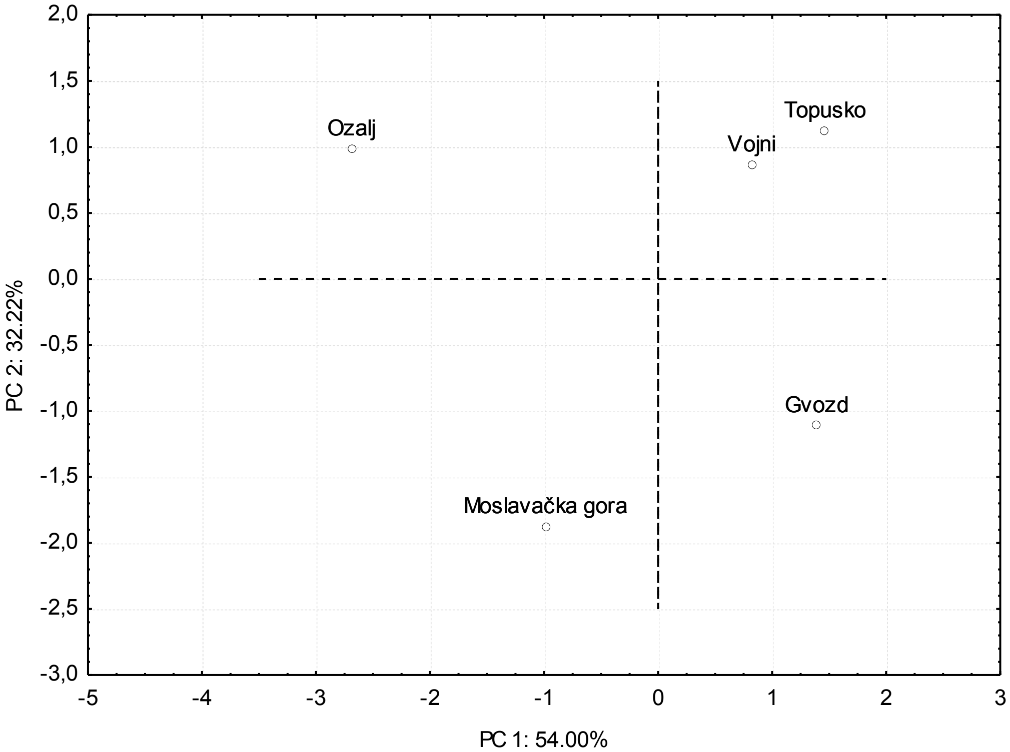

Figure 3. Score plot of the chestnut populations projected on the space of PC1 vs. PC2.