ISSN 2334-9883

UNIVERSITY OF KRAGUJEVAC
FACULTY OF AGRONOMY ČAČAK

PROCEEDINGS
CONFERENCE OF AGRONOMY STUDENTS

with international participation

Vol. 10, Issue 10, 2017

Čačak, 23-25 August 2017

CONFERENCE OF AGRONOMY STUDENTS

ORGANISER AND PUBLISHER

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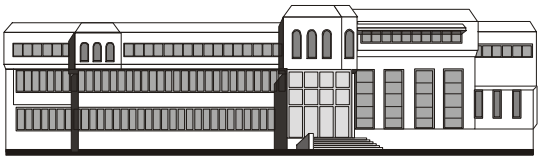
Cara Dušana 34, 32000 Čačak
e-mail: afdekanat@kg.ac.rs
www.kg.ac.rs



For the Publisher:
Prof. Dr. Vladeta Stevović

Computer editing and typesetting: Dalibor Tomić, B. Sc., Dušan Marković, B. Sc.
Cover page: Dr. Snežana Tanasković

Supported by: Ministry of Education, Science and Technological Development, Republic of Serbia and City of Čačak

Printed and bound by: "Studio za dizajn", Vukašina Ignjatovića br. 12, Čačak
Number of copies: 120

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The Tenth Conference of Agronomy Students

Čačak, Serbia

23 - 25 August, 2017

INTRODUCTION

Knowledge and skill of food production have a unique role in humans' lives. It is the foremost civilization skill. Nowadays, agriculture, as one of the oldest human activities, is a highly demanding production which merges knowledge from considerable number of fundamental and biotechnical sciences. This presents a challenge for the education of the students of agronomy and agricultural faculties.

The efforts to provide a student meeting point for discussing issues related to the acquired knowledge in the field of agriculture led to the First Conference of Agronomy Students which was held at and organized by the Faculty of Agronomy in Čačak, Serbia, in 1998. Today, we hope that the Tenth Conference of Agronomy Students will provide a forum for students-researchers in the field of biotechnical sciences contributing to the vibrant life of biotechnology research.

As the organizers of the Tenth Conference of Agronomy Students we encourage the students and their mentors to actively participate in this event by submitting projects, researches, experiences, and other theoretical and practical contributions as well as by transferring knowledge and expanding academic network.

This is the tenth Conference presenting 65 students' papers at three levels of study (bachelor, master, and doctoral) from XX universities and XX European countries. The submitted, presented, and printed papers are the part of scientific and research activities of the students at different levels of studies and of their mentors. The papers are printed as submitted by the authors.

We offer out thanks to all the participants of the Tenth Conference of Agronomy Students inviting them to participate in the next Conference as contributors or mentors.

Čačak, August, 2017

Sadržaj

Chemical features and quality assessment of the natural mineral waters in the Vrnjačka Banja area, Serbia

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Abstract: Water is one of the most precious natural resources. The aim of the study was a preliminary examination on mineral waters quality (S1–S5) in the Vrnjačka Banja area, Serbia, through the standard physico-chemical parameters: temperature, pH value, conductivity, turbidity, content of chloride as well as the total organic matter. All samples of water were collected and analysed in the period April-May 2017. The obtained results were compared to the National and World Health Organization (WHO) water quality standards. The results for temperature, pH and conductivity were within the values defined by Regulation on the quality of mineral water, except for the conductivity in samples S2 and S5 that were slightly above prescribed (2980 and 3460 μS cm^{-1}, respectively). Increased turbidity was observed in the sample S4 (5.24 NTU). The concentrations of total of organic matter in all analyzed samples were around 45 mg L^{-1} which indicates that the found values were 9 times greater than allowed and it can be result of a number of natural factors or the geographical location of the source itself.

Key words: mineral waters, water quality, chemical characteristics, Vrnjačka Banja

Introduction

Water quality is of a vital importance for mankind given the direct connection between water and human survival (Rajic et al., 2012). It is an important substance to all life both living and non-living and also is regarded as a universal solvent capable of dissolving nearly all solutes. Water quality is known to perform essential roles in human health (Boe-Hansen, 2001). Water is

a resource that has many uses, including but not limited to: recreation, transportation hydroelectric power-making, domestic, industrial, commercial uses (Bartram and Balance, 2006). In light of the current global development, water protection and management are positioning themselves as top priorities for preservation of the modern civilization. Despite the enormous amounts of water available in nature, its usability has been significantly decreased by pollution (Jiang, 2006). Human body is mostly made out of water (Turgut et al., 2005). Mineral spring waters represent a significant natural source of minerals necessary in the human organism (Baba et al., 2008). Water qualifies as "healing" or mineral if it contains more than one gram of dissolved matter per liter. Mineral waters which spring from greater depths, often have an increased temperature and therefore qualify as thermo-mineral. According to the density of occurrences and the diversity of physical and chemical features of the mineral waters, the territory of Serbia makes one of the richest areas of the European continent, but only a small quantity of these mineral waters is being bottled (Petrović et al., 2010). The global geological conditions dictate the speed of water exchange, but they do not correspond completely with the quality of the ground water. Therefore, the knowledge of the physical, chemical and biological parameters of water is very important for determining its type and quality (Kostić et al., 2016).

The purpose of this research was the preliminary quality assessment of mineral waters from the Vrnjačka Banja area, Serbia, through analysis of the following chemical and physical features: temperature, pH value, conductivity, turbidity, content of chloride and the total organic matter (TOM). Results were compared to the National and World Health Organization (WHO) water quality standards.

Material and methods

Study area

The Raška district is one of eight administrative districts of Šumadija and Western Serbia. It expands to the south-western part of the country. The administrative center of the Raška district is Kraljevo, which is about 25 kilometers away from Vrnjačka Banja (43° 37'/ N,20°54'/E). The geographical position of the locations is shown in Figure 1. The following samples are collected in the Vrnjačka Banja area: thermo-mineral source Snežnik (S1), Jezero (S2), thermo-mineral source Topla voda (S3) thermo-mineral source Borjak (S4), as well as thermo-mineral source Beli izvor (S5). All samples of water were collected and analysed in the period April-May 2017, in dark glass bottles, which had previously been rinsed with distilled water and sterilized with 70% alcohol.

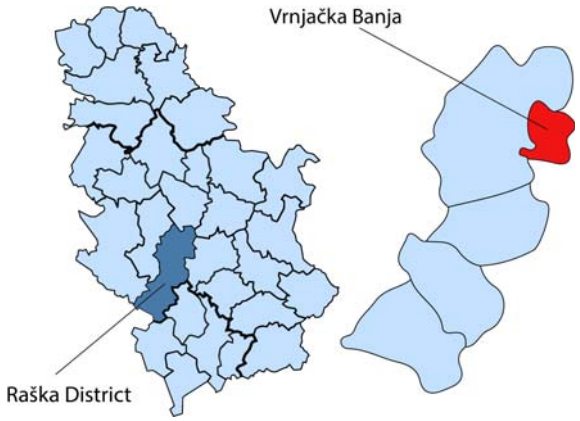

Figure 1. Geographical position of Vrnjačka Banja area

Determination of physicochemical properties

The temperature of the samples was measured with a thermometer and expressed in °C (Yu et al., 2009). The pH value and conductivity were measured using a pH meter and conductometer (sensION+ MM 374 GLP 2 channel Benchtop Meter) (APHA, 2012). Turbidity was measured by nephelometry using Handheld Turbiditimeter (Turb 430 IR) (APHA, 2012). The chloride content was determined by volumetric titration using standard solution of silver-nitrate (0.1 mol L^{-1}) with potassium-chromate (K_2CrO_4) as an indicator (Mohr's method) (Waters-Doughty, 1924). The total content of organic matter was determined using Kubel-Tiemann method (titration with a potassium-permanganate in acid solution) (Feliks and Škunca-Milovanović, 1990).

Results and discussion

The results of analyzed physicochemical parameters in water samples are shown in Table 1.

The temperature of analysed water samples was in the range 17.0–36.0 °C. The highest temperature value was recorded for the sample S3, and water from that source belongs to moderately warm waters. It is important to mention that mineral water from that spring is used to enhance digestion and help treat stomach and gallbladder illnesses. It improves epithelialization of the gastrointestinal and the urogenital mucosa. This mineral water is applied orally (through drinking), through inhalation, as an enema and as a vaginal spray in treatment of the above mentioned illnesses. It is also utilized in treatment of degenerative and inflammatory diseases of skeletal system as a mineral bath.

The pH value of the analysed water samples was in the range 6.42–6.88, which is within the value range defined by the recommendations of UNESCO/WHO/UNEP

(Chapman and Kimstach, 1996). Due to the influence of the pH value on the chemical properties of water, determining it is very important (Saritpongteeraka and Chaiprapat, 2008). The obtained results showed that the studied water samples were moderately acidic as expected. The lowest pH value (6.42) was measured in sample S1 (Snežnik) while the highest pH value (6.88) was recorded in S4 (Borjak).

Conductivity is the electrical property of water, and depends on the ions present in it - their concentration, mobility and charge, as well as the temperature on which it is measured. According to the legislation of the Republic of Serbia and the World Health Organization (WHO) the maximum allowed conductivity in natural mineral water is 2500 μS cm^{-1} (Official Gazzete, 2008; WHO, 2008). As presented in Table 1, samples S3 and S5 had higher values than allowed, 2980 and 3460 μS cm^{-1} respectively, which indicates that those samples contained an increased concentration of dissolved salts.

Turbidity of water is caused by suspended inorganic and dispersed organic substances, and is the result of the optical activity of substances dissolved in it. In most tested water samples, measured turbidity was < 5.00 NTU, except in the sample S4 (5.24 NTU) that had a slightly higher value than allowed. This may be linked to several factors such as the geology of the surrounding terrain, the presence of organic and inorganic materials, and the sudden inflow of surface water in the rainy season.

Table 1. Physicochemical parameters of investigated water samples

Sample	**S1**	**S2**	**S3**	**S4**	**S5**	MAC*
Temperature (^0C)	17	27	36	19	22	-
pH	6.42	6.49	6.48	6.88	6.55	6.5-9.5
Conductivity ($\mu S\ cm^{-1}$)	1397	2980	2150	1215	3460	2500
Turbidity (NTU)	2.77	1.44	0.89	5.24	4.24	5
Cl^- ($mg\ L^{-1}$)	21.62	35.09	34.74	20.56	46.79	250
Total organic matter ($mg\ L^{-1}$)	48.40	45.60	46.80	47.60	44.00	5

*maximum allowed concentration (MAC) in water for human use (Official Gazzet, 2008)

In all tested samples the presence of chloride was in the range from 20.6 to 46.8 mg L^{-1} (Table 1). The greatest amount of chloride ions was found in sample S3, while sample S4 showed the lowest values of this parameter. There is no evidence that the increased concentration of chloride can affect human health. However, chloride may have an effect on taste and colour of water (WHO, 2008).

In water containing organic substances of human, animal, plant or industrial origin, a certain amount of potassium-permanganate is spent for their oxidation (depending on the amount of organic matter in water) (Chapman and Kimstach, 1996). According to the law of the Republic of Serbia, the maximum allowed concentration of total of organic matter in natural mineral waters is 5.0 mg L^{-1}. All the analyzed samples had similar values of around 45 mg L^{-1} which indicates that the found values were 9 times greater than allowed. The organic substances present in the water do not have to be pollutants, but may naturally be present in a sample because of the field geology.

Conclusion

In this research we obtained the results of physicochemical parameters for 5 different water samples from the Vrnjačka Banja area. All the samples turned out to be thermo-mineral. The analyzed parameters were within the following ranges: temperature 17–36°C, pH 6.42–6.88, conductivity 1215–3460 μS cm^{-1}, turbidity 0.89–5.24 NTU and chlorides 20.56–49.79 mg L^{-1}. Obtained values were then compared to the referent maximum values of the analyzed natural mineral water parameters stated in the Regulations on water quality. The results showed that pH value was within the prescribed range in all samples, but the conductivity values were slightly above the prescribed in samples S2 and S5. Turbidity was higher than the prescribed maximum value in sample S4. All the tested samples displayed significant deviations from the maximum prescribed values for total organic matter, which can either be a result of a number of natural factors or the geographical location of the source itself.

Acknowledgements

This research was done at Faculty of Agriculture, University of Belgrade, Department of Chemistry and Biochemistry. The authors thank PhD V. Rac from the department for his help and support.

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CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

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PROCEEDINGS conference of agronomy students with international participation / za izdavača Vladeta Stevović. - Vol. 10, issue 10 (2017)- . - Čačak : Faculty of Agronomy, 2013- (Čačak : "Studio za dizajn"). - 24 cm

Je nastavak: Smotra naučnih radova studenata agronomije = ISSN 1450-7323
ISSN 2334-9883 = Proceedings conference of agronomy students
COBISS.SR-ID 204397836