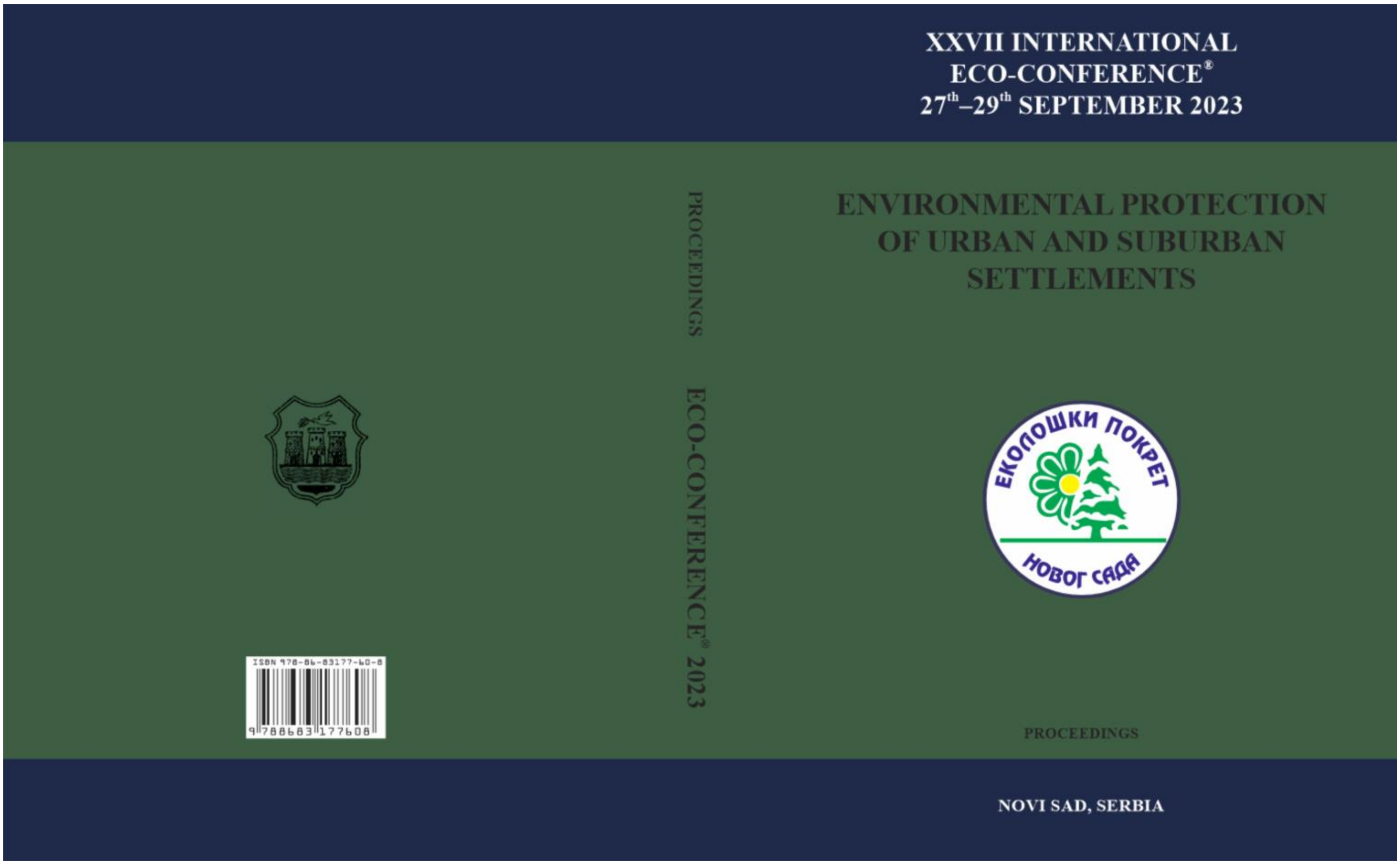
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INFLUENCE OF HIGH CONTENT OF HEAVY MEATLS IN WATER ON HUMAN HEALTH AND METHODS FOR CLEANING OF CONTAMINANTS

Abstract

Higher level of arsenic, iron and manganese in water, that is used for water suply of general population, represents a great problem considering that chronical exposure to arsenic, primarly through drinking water, can cause several health issues on skin, cardiovascular, respiratory, gastrointestinal, vascular and nervous systems. In most cases, high level of arsenic in water, refelects different natural and geochemical processes that naturally occur. However, numerous antropogenic activities that in great measure contribute to contamination of this important natural resource can not be overlooked.

Key words: *heavy metals, water, protection of environment, ecological responsibility*

INTRODUCTION

Process of ensuring enough quantites of clean water for general populus requires usage of knowledge from several different science fields, theoretical and practical approach, cooperation of several experts from different fields and demands commitment and certain level of responsibility. Primary goal of planning, designing and constructing of tehnological lines for water processing and cleaning is production of chemicaly and biologicaly clean water, using of which does not long term present risk for human health and whose quality is within legal boundaries prescribed by the state. As primary goal of protecting human health and lovering the risks coused by unhealthy water consumtion, and considering the recomedations from WHO (world health organisation), many states including the Republic of Serbia, adopted the 10 µg/l of arsenic as highest allowed concentration in drinking water (Nikic, 2019). Water, as primary component of each organ and organism, is needed in certain amounts for propper body functioning. Under or over intake of water can cause different health issues, and even death. Also, several chemical supstances and their chemical compounds, such as arcenic, manganese or lead can be be found in water and cause serious health issues and damage (Zeciri, 2020).

Chronical exposure to arsenic through water and food causes serious problems for more than 100 milion people globaly. Most affected countries are from southeast Asia, such as Bangladesh, West Bengal and India. Drinking water and water for irigation of plants in these countries is from deep wells with extremely high concentrations of arsenic compounds. Such water doesn't meet health requirements of drinking water, which is main cause for serious illnesses.

Most toxic form of arsenic is arsenic (III), which can bi transformed through oxidation to less toxic form of arsenic (IV) and with further transformation in organic forms, monometylated and and dimetylated arsenic compounds. Natural pathways for arsenic removal from body are based on metlation processes with help of enzyme arsenit metiltransferaze, while methods of removing from water are based on axidation and processes such as coagulation, filtration, flocculation, etc. (Bogdan, 2022).

The aim of research was to analyse heavy metal content in water samples collected on area of South Banat, municipality of Vojvodina and reach the conclusion whether the content in samples is higher from maximum allowed concentrations of heavy metals in drinking water.

MATERIAL AND METHODS

In area of South Banat, fifteen samples of water was collected and analysed (0-15): local water pipeline and individual wells.

Content of macro and mictroelements were measured using analitical technique of inductive coupled plasma with optic emission spectrometry, ICP-OES.

Other than acute risk on health caused from drinking water with higher content of toxic elements, it is possible to determine chronic, potentialy cancerogenic, risk on human health. As parameters for, this type of risk evaluation Uoral is applied, and also risk coefficient from oral intake of toxic elements, Kroral, using following equations:

$$U_{oral} = [PPV \cdot c \cdot 365 \cdot 30]/[PTM \cdot 10950]$$

$$KR_{oral} = U_{oral}/RfD_{oral}$$

Where PPV is average consumption of water per capita (1.5 liters per day), c-concentration of elements in examined samples of drinking water, (µg/L), PTM is average body weight of residents in South Banat, which is 75.65 kg., and TNU is tolerant weekly intake of toxic metals, expressed as µg/kg of body weight. (Pavlica et al., 2010).

RfDoral are refferent values for intake of cancerogenic and potential cancerogenic contaminants through oral intake, prescribed from American agency for environment protection EPA (Momot i Synzynys, 2005).

RESULTS AND DISSCUSION

Based on results of physio-chemical analysis of samples of drinking water (Table 1) it can be seen that several samples have higher concentrations of some elements, when compared with values prescribed in Baylaw of hygienic state of drinking water (Sl. glasnik RS, br. 28/2019).

Table 1. Phisio-chemical examination and content of macro and microelements [mg/L] in samples of drinking water from South Banat

Ord. Num.	Parameter	Unit of measure	Methode mark	MDK	Result
1.	Colour	Pt-Co	SRPS EN ISO 7887:2013	5	18
2.	Smell	/	HDMI-002	without	without
3.	turbidity	NTU	HDMI-003	5	1,4
4.	pH value	/	SRPS EN ISO 10523:2016	6,8-8,5	7,88
5.	KMnO4 used	mg/L	HDMI-009	12	2,9
6.	Fumes residues at 105 C	mg/L	HDMI-012	-	455
7.	Electroconductivity	µS/cm	HDMI-011	2500	758
8.	Amonia (NH3)	mg/L	HDMI-029	1	0,65
9.	Hlorides	mg/L	SRPS ISO 9297:1997, SRPS ISO 9297/1:2007	250	74,7
10.	Nitrates (NO3)	mg/L	HDMI-005	50,0	2,6
11.	Nitrites (NO2)	mg/L	HDMI-004	0,03	<0,006
12.	Iron (Fe)	mg/L	HDMI-017	0,3	0,71
13.	Manganese (Mn)	mg/L	HDMI-018	0,05	0,16
14.	Arsenic (As)	mg/L	SRPS EN ISO 17294-2:2017 SRPS EN	0,010	0,026

			ISO 15587-2:2009		

People that use drinking water in which traces of arsenic and manganese exist are in risk of developing cancer. Several elements can be essential for positive processes in human body, such as Co, Cr, Cu, Fe, Mn, Se and Zn, but there are also potential toxic elements, such as Ag, Al, As, Cd, Pb and Ni. However, deficiency and sufficiency of essential elements can have negative effects on human health (Peric-Grujic et al., 2009).

Arsenic intake in body through water and food results in higher concentrations in bloodstream, nails and hair, causes enzyme inactivation and can souse carcinome development (Huzjak, 2018). Arsenic is toxic element which causes skin, tongue, liver deseases and kidney carcinome (Simonic, 2009). It's assumed that arsenic crosses in underground water from deep soil layers. It is also important to say that arsenic concentration is reduced through water processing steps.

Arsenic concentration in underground waters in some parts of the world are a lot higher than maximum allowed concentrations. Highest values of arsenic in water are recorded in countries of Southeast Asia, ranging from 400 to 3400 g per liter of water, next are countries of Southeast America where values of arsenic in water are ranging from 140 to 58,5 gr per liter of water (Orescanin, 2013). Higher potential risk for poisoning with arsenic presents consumption of contaminated water (unorganic forms) than consuming water with microorganisms that hawe arsenic in their bodies (organic forms). Next to oral poisoning, arsenic can be introduced in human body through skin adsorpiton and by breathing contaminated air. It is also recorded that some individuals poisioned themselves by smoking tobaco that was grown in soil that was irrigated with water that was contaminateed with arsenic (Kukucka i Kukucka, 2013). Researches have shown that arsenic in underground waters is mainly in form of As3+, that is more toxic than arsenic in its organic form (Damjanovic, 2015).

Human exposure to arsenic is mainly through food and drinking water. Only several percent of total arsenic in fish is in inorganic form. Chronical exposure to arsenic can have serious effect on periferal and central nervous system. (Vojvodic, 2019). In this research arsenic level in samples was 0.026 mg per liter of water, which is slightly above maximum allowed concentrations set by Bylaw (0.010 mg per liter of water).

In environment, manganese is rarely in its free form, but mainly in compounds. In its pure form, manganese is reactive element, and in presence of air is combustable. Some manganese compounds are water soluble, and therefore significant exposure to this element can also be through drinking water. Manganese, when ingested, can cause disfunctions in lungs, liver and vascular system activity, drop in blood pressure, abnormalities in fetus growth and brain damage (Vojvodic, 2019). In analised water samples in this research, significantly higher values of manganese (0.16 mg per liter) were measured when compared to maximum allowed concentrations set by Bylaw (0.05 mg per liter).

When iron is in question it is impossible to determine longterm risk on health, considering that this element is not on EPA list of potentially cancerogenuous supstances. This fact, however does not justify higher concentrations of iron recorded in examinated samples, where a lot higher concentration (0,71 mg/L) was recorded, when compared to maximum allowed concentration (0,3 mg/L). Despite it's toxicity, iron is essential for several body processes, including DNA syntesis, as part of chemoglobin for storage and transport of oxygen. Iron defficiency can lead to cell death (Vojvodic, 2019).

Next to physio-chemical samples analysis of drinking water from region of South Banat, microbiological analysis of water samples was conducted.

Table 2. Microbiological analysis of drinking water samples from South Banat

Ord. Num.	Parameter	Unit of measure	Methode mark	Ordinal value	Result
1.	Total coliform bacteria	MPN/100mL	Prirucnik[1)] Deo 2a Metoda 1.2.1/37°C	0	<1
2.	Coliform bacteria of fecal origin	u 100 mL	Prirucnik[1)] Deo 2a Metoda 1.2.2/44°C	Can't contain	Isn't isolated
3.	Streptococcus of fecal origin	u 100 mL	MDMI-004/37°C	Can't contain	Isn't isolated
4.	Sulphytoreducting clostridia	MPN/100mL	Prirucnik[1)] Deo 2a Metoda 5.1.1/37°C	0	<1
5.	Proteus species	u 100 mL	Prirucnik[1)] Deo 2a Metoda 4.1/37°C	Can't contain	Isn't isolated
6.	Pseudomonas aeruginosa	u 100 mL	Prirucnik[1)] Deo 2a Metoda 6.1.1/42°C	Can't contain	Isn't isolated
7.	Total number of aerobic mesophylic baceria	Cfu/mL	SRPS EN ISO 6222:2010/37°C	<_10	<1

Based on results of research, in regard to parametres measured, samples are IN LINE with demands from Bylaw of hygenic standards of drinking water, section 3. subsection 1 (Sl.list SRJ, br.42/98 i 44/99 and Sl. glasnik RS, br.28/2019).

REMOVING UNVANTED METALS IN WATER

In order to reduce ecological disbalance caused by precence of heavy metals ions, emission of this ions in envirornment must be reduced. To achieve this it is neccesary to remove ions of heavy metals from waste waters before it's release in recipients. Conventional methods for metals ion removal from water are through chemical precipitation, coagulation, flotation, electrochemical methods and adsorption. However, none of cleaning processes can't provide good enough results becouse of complex nature of affluents. In practice, usually several methods are used simultaniously in order to achieve requiered quality of water *(*Ahmaruzzaman, 2011).

In facilityfor production of water for human consumption, processed water from this facility was filtered through two filters with different work regimes that are filled with adsorbent material AKUARTIS-Hidrofilt.In water samples concentrations of arsenic, manganese, amonia and iron were measured for five months. Results have shown that there was not increase in levels of measured supstances above of MAC for: aresenic, iron, manganese or amonia throught whole five months period, nor that there was decerase in overall water quality (Bircic, 2017).

With use of membanes of small enough mash efficient removing of metal ions from water can be achieved. Ultra filtration is not recommended fro this use, because of large pores diameter (mash) through which hidrated ions of metals can pass. However, researches have shown that by adding materials with active surface in amount that exceeds critical micelar concentration, and micelia is formed, or by adding in water soluble polimers that can bind heavy metal ions, these polutants can be removed efficiently even with use of ultrafiltartion. (Fu and Wang, 2011).

In recent years, ultracelulose waste is examined as potential adsorbent for heavy metal removal from waste waters (Sciban, 2013). Removing of heavy metals from water is possible by biosorption from lignocelulose biomaterials that have relative porous structure and different functional groups on it's surface. Hydroxil, karboxyl, phosphorus, amino and thiol groups play major role in heavy metal binding, in this species of biomaterials. However, presence of above mentioned functional groups of surface of biomaterials does not guarentee efficient removal of heavy metals ions, because of several other factors that influence bioadsorption process, such as: nimber of active places, their accessibility, chemical properties of active places and their affinity to targeted metal, which suggests that bioadsorption depends greatly on tipe of biomass used. (Park et al., 2010; Nguyen et al., 2013).

CONCLUSION

Drinking water is essential for life on whole planet Earth. Primary sources for human consumption are wells, underground and surface waters.

Data analysis on longterm health risks shows that only real threat exist in regard to amount of As-arsenic in drinking water.

Filtration of water for human use represents combination of natural, self preserving process of sedimentation and phisio-chemical processes of filtration and oxidation. Water filtration can be done eith use of slow and fast filters. With use of nanofiltration it is possible, with adequate before and after treatmant (desinfection), to remove all unwanted supstances from underground waters in Republic of Serbia and get clean and safe drinking water. Disinfection ensures health safety of water an therefore is main an most important step in processes of water cleaning for human use. It is performed with physical and chemical processes and radiation. Presence of iron and manganese in water in concetrations higher than 0,3 mg/ per liter and 0,5 mg/per liter changes organoleptic properties of water, and it is necessary to take certain steps to remove surplus of these elements. Removal is mainly done through processes of oxidation.

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UTICAJ VISOKOG SADRŽAJA TEŠKOG METALA SA U VODI NA ZDRAVLJE LJUDI I METODE ČIŠĆENJA OD ZAGAĐIVAČA

Apstrakt

Veći nivo arsena, gvožđa i mangana u vodi, koja se koristi za vodosnabdevanje opšte populacije, predstavlja veliki problem s obzirom da hronična izloženost arsenu, pre svega kroz vodu za piće, može izazvati niz zdravstvenih problema na koži, kardiovaskularnim, respiratornim, gastrointestinalnim , vaskularni i nervni sistem. U većini slučajeva, visok nivo arsena u vodi, odražava različite prirodne i geohemijske procese koji se prirodno dešavaju. Međutim, ne mogu se zanemariti brojne antropogene aktivnosti koje u velikoj meri doprinose kontaminaciji ovog značajnog prirodnog resursa.
Ključne reči: *teški metali, voda, zaštita životne sredine, ekološka odgovornost*

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PLANTS AS INDICATORS OF WATER POLLUTION

Abstract

Water pollution with various pesticides, organic compounds, metals, and microorganisms is the main link in environmental pollution. The

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