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ORIGINAL ARTICLE

Physico-Chemical and Bacteriological Analysis of the Water from *Jallaq* Spring in Kosovo

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ABSTRACT
The Jallaq spring is located in east part of Kosova. Bacteriological, physico-chemical and some metals were analyzed. The samples were taken for the analysis during September 2012, November 2012 and March 2013. Also some physico-chemical parameters are determined: water temperature, pH, conductivity (EC), turbidity, total hardness, consumption of $KMnO_4$, chlorides, sulfates, phosphate, alkalinity, acidity, ammonia, nitrates and nitrites. We did also the bacteriological analysis such as total coliform bacteria, coliform bacteria of faecal origin, total number of aerobic bacteria, sulphide reducing bacteria and streptococcus of faecal origin. According to the bacteriological analysis, the water spring from Jallaq is not responding to standard I.A.2/99. From the results, we found that all metals are under maximum level of WHO and EU standards for drinking water, except lead (0.058-0.065 mg dm^{-3}), mercury (8.1 $x10^{-3}$- 9 $x10^{-3}$ mg dm^{-3}) and iron (0.285-0.332 mg dm^{-3}). From these results we can conclude that this water can be used for drinking but first it should treat to remove lead, mercury and iron.
Keywords: Jallaq spring, bacteriological, physico-chemical, metals

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INTRODUCTION

Scarcity and misuse of fresh water pose a serious and growing threat to sustainable development and protection of the environment. Human health and welfare, food security, industrial development and the ecosystems on which they depend, are all at risk, unless water and land resources are managed more effectively in the present decade and beyond than they have been in the past [1]. Overexploitation of nature and uncontrolled use of natural resources, including inadequate processing of industrial wastes have caused large contamination of world ecosystems by toxic metals (Hg, Pb, Cd, Cu, Zn, Ni, Mn). Decomposition of organic matter and pollution due to anthropogenic activity are the main sources of pollution of water and stream sediments [2-3]. Therefore, multidisciplinary collaborative research is essential for understanding the pollution processes. Determination of total quantitative and qualitative metals and distribution of all physical and chemical forms in traces (speciation) in natural water equilibrium resources today is to be considering as the main challenge for most of the scientists [4]. Based on the results of such studies, it will be possible in the future to propose protection and detoxification measures of affected river waters and general protection and remediation of ecosystems. This work is a continuation of earlier studies of surface waters in Kosovo [5-8]. One could claim that the most polluted areas in the world are those with the densest population. It should therefore be the foremost goal of environmentalists to prevent such pollution, and to educate the population towards proper management of ecosystems [9]. In this work we have determined the quality of water from Jallaq spring based on the concentration of metals, physic-chemical and bacteriological parameters.

MATERIALS AND METHODS

Sample collection

Water for analysis was obtained from spring known as *Jallaq* (In east part of Kosovo). Samples are taken on September 2012 (sample S_1), November 2012 (sample S_2) and March 2013 (sample S_3). Water samples were taken in polyethylene bottles and HNO_3 was used to conserve samples (till pH=3.5). Then samples we keep in the temperature of 4^0C till we have analyzed.

Determination of physico-chemical parameters

For the determination of the quality of this water we have used standard methods for water analyzes including classical and contemporary methods. Temperature of water was measured immediately after sampling, using digital thermometer, model "Quick 63142". Measurements of pH were performed using pH/ion-meter, Hanna Instruments (Portugal). Electric conductivity was measured by conductometer, InoLab WTW, Weilheim, Germany. Turbidity was measured with turbidity meter HACH 2010 P. Total hardness was determined by EDTA titration, using Erichrome Black T indicator. Consumption of $KMnO_4$, acidity and alkalinity was determined with volumetric methods. Determination of chlorides was conducted with Mohr method [10], sulfates according to Schmids [10]. Phosphates, ammonia, nitrates and nitrites were determined with spectrophotometer method [10]. For that we have used Spectrophotometer HACH DR/2010. Standard solutions for each parameter were prepared in the laboratory from the chemical pure substances, "Merck'' with distilled water.

Determination of trace metals

We used the ICP/OES (Inductively coupled plasma in combination with optical emission spectrophotometer- Perkin Elmer-ICP OES OPTIMA 2100 DV) method to determine the concentration of metals.

Bacteriological analysis

Samples are taken in plastic sterile bottles at 30 cm depth, cooled in icebox, immediately transported to laboratory and were examined on the same day. The coli form bacteria were evaluated at 30 °C (agar plate) according to probable number technique (MPN) 100 cm^3. Total bacteria of fecal origin were evaluated at 44°C (endo agar plate). Total mesophylic bacteria were evaluated at 37°C (plate count agar) according to "colony star" (Frank Gerber), 1MPN technique. Sulfide reducing anaerobe bacteria were evaluated at 37°C (sulfide agar plate).

RESULTS AND DISCUSSION

Physico-chemical parameters

In Table 1 are presented several physico-chemical parameters measured in water of *Jallaq*: odor, taste, color, temperature, pH, electrical conductivity (EC), turbidity, total hardness, alkalinity and acidity.

Table 1 Physical-chemical parameters determined in water of *Jallaq* spring

Parameters	Sample		
	S_1	S_2	S_3
Odor	odorless	odorless	odorless
Taste	tasteless	tasteless	tasteless
Water temperature / ^{0}C	17.7	17.2	16.4
pH	7.8	8.13	8.25
ECκ//µS cm^{-1}	115	120	110
Turbidity/NTU	0.95	0.87	0.81
Total hardness/ ^{0}D	1.95	2.24	2.4
Color/Pt-Co	5	6	6
Alkalinity/mvaldm^{-3}	7	8	7
acidity/mvaldm^{-3}	0.027	0.032	0.030

The color, taste and odor were found within the WHO permissible levels. The lowest temperature was 16.4 ^{0}C in sample S_3, and higher temperature was 17.7 ^{o}C in sample S_1. pH range from 7.8 in sample S_1 and 8.25 in sample S_3. The pH level was well within the acceptable range. Conductivity was between 110 µS cm^{-1} and 120 µS cm^{-1}. Higher conductivity was in sample S_2 and the lowest was in sample S_3. Total hardness was 2.4 ^{o}D (sample S_3) and 1.95 ^{o}D (sample S_1). The conductivity and total hardness are within the limits of acceptable standards. The turbidity value ranged between 0.81 - 0.95 NTU, which means that this water is "clean" water. The lowest alkalinity was 7 mvaldm^{-3} in sample S_1, S_3, and higher alkalinity was 8 mvaldm^{-3} in sample S_2. Acidity was between 0.027 mvaldm^{-3} and 0.032 mvaldm^{-3}. Higher acidity was in sample S_2 and the lowest was in sample S_1. In table 2 are shown results for chlorides, sulfates, phosphates, nitrates nitrogen, nitrites nitrogen, ammonia nitrogen and consumption of $KMnO_4$.

Table 2 Chemical parameters presented in mg dm^{-3}

Parameters	Sample		
	S_1	S_2	S_3
Cl^-	5.2	6	8.6
PO_4^{3-}	0.175	0.198	0.185
SO_4^{2-}	15.6	12.5	14.2
NO_3-N	1.2	1.7	1.5
NO_2-N	0.0018	0.0025	0.0021
NH_3-N	-	-	-
Consumption of $KMnO_4$	0.65	0.93	0.81

The amount of chlorides, sulphates, nitrates nitrogen, nitrites nitrogen, ammonia nitrogen and phosphates ions ranges from 5.2 -8.6 mg dm^{-3}, 12.5-15.6 mg dm^{-3}, 1.2-1.7 mg dm-3, 0.0018-0.0025 mg dm^{-3}, 0.0 and 0.175-0.198 mg dm^{-3}, respectively. So the concentration of these chemical parameters is below the maximum value allowed by WHO and EU standards [11-12].

Consumption of $KMnO_4$ in the water spring *Jallaq* has value of 0.65-0.93 mg dm^{-3}. This low value means that this water is not contaminated with organic pollutants. In table 3 are shown concentrations of ten metals in the water spring *Jallaq*.

Table 3 Metals in the water spring *Jallaq*

Parameters/ mg dm^{-3}	Sample		
	S_1	S_2	S_3
Mn	0.0015	0.002	0.0014
Fe	0.322	0.332	0.285
Cu	0.0059	0.0052	0.0047
Ni	0.0083	0.008	0.0075
Cr	0.0034	0.0039	0.0029
Cd	$<1 \times 10^{-4}$	$<1 \times 10^{-4}$	$<1 \times 10^{-4}$
Zn	0.157	0.162	0.170
Pb	0.058	0.062	0.065
Hg	8.5×10^{-3}	9×10^{-3}	8.1×10^{-3}
Co	$<2 \times 10^{-4}$	$<2 \times 10^{-4}$	$<2 \times 10^{-4}$

From table 3 the concentrations of manganese, copper, nickel, chromium, cadmium, zinc and cobalt are below the maximum value allowed by WHO and EU standards [11-12]. Also from table 3, we can see that one metal iron (0.322mg dm^{-3} sample S_1, 0.332 mg dm^{-3} sample S_2 and 0.285 mg dm^{-3} sample 3) are in higher concentrations compared to EU standards for drinking water (for iron max. value in drinking water is 0.2 mg dm^{-3}). Also from table 3, we can see that two metals lead (0.058 mg dm^{-3} sample S_1, 0.062 mg dm^{-3} sample S_2, and 0.065 mg dm^{-3} sample S_3) and mercury (8.5×10^{-3} mg dm^{-3} sample S_1, 9×10^{-3} mg dm^{-3} sample S_2, and 8.1×10^{-3} mg dm^{-3} sample S_3) are in higher concentrations compared to WHO and EU standards for drinking water (for lead max. value in drinking water is 0.01 mg dm^{-3} and mercury 1×10^{-3} mg dm^{-3}).

In Kosova we don't have standards yet, so we decided to use the Croatian Standards to discuss the results [13]. In table 4 are shown the classifications of water samples of the *Jallaq* spring based on the concentrations of toxic metals.

Table 4 Classification of water from *Jallaq* spring based on some trace metals as pollutant indicator

Metal ($\mu g\ L^{-1}$)	Water class				
	I	II	III	IV	V
Cu	<2	2-10 $S_1, S_2\ S_3$	10-15	15-20	>20
Zn	<50	50-80	80-100	100-200 $S_1, S_2\ S_3$	>200
Pb	<0.1	0.1-2.0	2.0-5.0	5.0-80 $S_1, S_2\ S_3$	>80
Cd	<0.1 $S_1, S_2\ S_3$	0.1-0.5	0.5-2.0	2.0-5.0	>5.0

The Water based on concentration of zinc and lead is classified in fourth class, based on the concentration of cuprum is classified in second class, and based of cadmium is classified in first class.

Bacteriological parameters

In Table 5 are presented bacteriological parameters of water.

Table 5 Bacteriological parameters of water spring *Jallaq*

Microbiological Parameter Cfu/cm³	Sample		
	S_1	S_2	S_3
Total Coliform bacteria/100 cm³	0	0	0
Coliform bacteria of faecal origin/100 cm³	0	0	0
Total number of aerobic bacteria/1 cm³	137	140	132
Sulphide reducing bacteria/100cm³	0	0	0
Streptococcus of faecal origin/100 cm³	0	0	0

The water is very clear and it doesn't contain any kind of coliform bacteria. As we can see from the table the total number of aerobic bacteria in 1ml of samples was about 132-140. According to this results the water from *Jallaq* spring is not responding to standard I.A.2/99 and should treated to remove bacteria.

CONCLUSION

Based on our results we can conclude:

- That we don't have differences in the value of parametres for the samples taken in different period time.
- The water is basic (pH = 7.8-8.25) and has low hardness (^{0}D = 1.95– 2.4)
- The concentration of iron, lead and mercury are higher than values allowed by WHO and EU standards for drinking water.
- According to the concentrations of cadmium, the *Jallaq* water was classifed in first class,. Based on the concentration of cuprum, the *Jallaq* water is clasifed in second class (the concentrations of toxic metals are in that level that can cause acute pollutions). Based on the concentration of zinc and lead, the *Jallaq* water is clasifed in fourth class.
- The water *Jallaq*, according to bacteriological analysis, is not responding to standard I.A.2/99.

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