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Drinking Water Before and After Processing in the Water Supply

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ABSTRACT
The quality and quantity of water throughout history have been an important factor in determining human well-being. Many types of pollution threaten rivers, including aquatic organisms, pesticides, soil erosion, chemical fertilisers and industrial pollutants. An extraordinary asset for our country is the natural waters where their quality is particularly important from a chemical point of view. From the studies carried out so far on the quality of natural waters, there are shortcomings mainly related to the limited number of physical-chemical parameters measured as well as to the water resources being processed. As for consumption, the quality of water is of great importance, and the purpose of this work is the analysis of water quality in the Aqueduct, which is of great importance for all residents who are supplied by this Aqueduct. The basic substance of life is water, therefore it is necessary to determine the quality of drinking water in the water supply network through physical-chemical and organoleptic parameters. The analysis of water in the water supply network was done before and after processing every four hours during the day and three days in a row. The obtained results show the condition and quality of raw water and processed water used by consumers, whereas a reference basis they are taken from Directive 98/83/EC for the quality of water for human consumption. From the results, we came to the conclusion that the water analyzed after processing is of sufficient quality to be used as drinking water.

Keywords: natural water, water quality, physico-chemical analysis, distribution, water supply, human consumption.

INTRODUCTION

Water is the most widespread chemical compound in nature and the most useful in all areas of human activity. The use of water in industry, agriculture and in daily activities for the preparation of various solutions as well as for the processes of washing, condensation, cooling, etc [Dakoli & Xhemalaj, 1997]. The demands for water and the supply of clean water are and will be for a long time. not easy challenges first for developing countries, but also for those with advanced technology [Hoxha, 1999.]. The water that can be used and is available to man does not exceed 3% of this amount, so when this percentage of fresh water is also removed from the water that cannot be used, being too far from settlements, or too deep in aquifers, then the lack of drinking water increases even further, already in the global, regional, national and local aspect [Dalmacia, 2000; Korça, 2003]. For water, not only the quantity is a challenge, but also its quality. The quality and quantity of water for man throughout history was a vital factor in determining his well-being [Çullaj, 2004].

Clean water is essential for life on Earth where many of the organisms that live in rivers can only live in clean, cold water. There are many types of pollution that threaten rivers including soil erosion, pesticides, runoff from herbicides, chemical fertilizers, and industrial pollutants [Davis & Masten, 2004].

Due to soil erosion, the rivers become cloudy, then the particles of dirt reflect the sunlight, causing the water temperature to rise, resulting in a decrease in the amount of dissolved oxygen in the water. Low oxygen levels make the water unsuitable for many organisms [Kosovo Environmental

Action..., 2006; MMPH…, 2008]. Like temperature and clarity, the presence or absence of various organisms in water streams is an indicator of water quality. For example, some microorganisms are only found in warm waters with low oxygen levels [Frashëri, 2013].

Water also has some specifics that should be mentioned regarding health and they are:

- helps to cleanse the body;
- helps to hydrate the body, which is essential for every cell in the body to perform its function;
- removes fatigue, fatigue is one of the first signs of dehydration;
- improves thinking ability;
- removes headache and migraine;
- facilitates digestion;
- promotes regular bowel movements;
- helps to reduce weight;
- cleanses the body of toxins;
- promotes kidney function, reduces kidney stones and salts;
- improves skin and hair health etc.

Natural waters are an extraordinary asset for our country and the assessment of their quality from a chemical point of view is of particular importance. Regardless of the studies carried out so far for the assessment of the quality of natural waters, there are still shortcomings related mainly to the limited number of chemical parameters measured as well as to the studied water sources. [REC, Progress monitoring…, 2008; Simunic, 2008] Water quality is of great importance. In terms of its consumption, therefore, the purpose of this paper is to control the quality of water in the Aqueduct, since water is very important for all residents who are supplied by this Aqueduct [Cullaj, 2010; Shallari, 2013].

The history of the water supply is closely connected with the history of Pristina – the capital of Kosovo and the settlements that are close to the capital. It should always be emphasized that after the Kosovo war (1998–1999), the company underwent a process of consolidation, namely regionalization, where they now extend their activities throughout the territory of central Kosovo. The water supply dates back to the early times from the natural sources of Germia and later from the wells in Kolevica. In this year, the Badovci storage lake began to be used to supply the city and its surroundings with drinking water. Regional Water Company "Prishtina" – joint stock company includes the provision of services in the municipalities: Prishtina, Fushë Kosovë, Obiliq, Shtime, Lipjan, Podujevë, Graqanicë, Drenas. Currently, the Regional Water Company "Prishtina" is the largest water company in Kosovo. Drinking water and wastewater services are offered to about 40% of the population of Kosovo connected to these services [Notes from the archives…].

PRACTICAL WORK AND METHODS

Prishtina is located in the north-eastern part of the Republic of Kosovo and is bordered by Besia, Vushtrri, Kastriot, Fushë-Kosova and Dardana. Its total area includes 572 km², the density is 360 inhabitants/km^2 and it has a population of 198,214 inhabitants. Coordinates (42° 40′ 0″) North and (21° 10′ 0″) East and altitude 652 m. Samples for drinking water analysis were taken at a single point and this point is located in Shkabaj, more precisely at the water treatment plant. Drinking water analyzes were performed 4 times a day every four hours and two samples were taken each time; one for raw water and one for treated water.

During sampling, standard tools were used, water samples were taken in glass bottles for organic parameters and in polyethylene bottles for inorganic parameters, which were labeled with the date and other data related to the sampling site, and were stored in refrigerators. at 4 °C then they were transported according to the relevant procedure. For daily analysis, water samples are taken in plastic or glass containers of 1 liter. While for periodic analysis where a large number of parameters are included, water samples are taken in volumes of 3–5 liters. For the analysis of some parameters, the sample is taken in special containers and immediately preserved according to analytical methods.

During sampling, let it flow from the tap for 3–5 minutes and then clean the bottle three times with water. The bottle is not filled completely, it is left empty for 10–15 ml and closed with a cork. During the taking of water samples, the temperature, organo-leptic properties are measured at the place of taking, while the sample is preserved for the analysis of other parameters. On the day of receipt, the sample is sent to the laboratory and immediately analyzed.

Standard methods are adapted for the analysis of different parameters. Considering that some water components in the samples taken may be volatile and easily decomposed, some of the parameters were measured directly in the field (mainly physical parameters). At each sampling site, the following were measured: water temperature, electrical conductivity, pH, dissolved oxygen and turbidity.

Color – First, let the sampled water run for a few minutes, then fill a glass and hold it up to the light. If the water is dark, yellow, or brown, it could mean rusty pipes, upstream pollution, or a low-quality water source like a river or reservoir. Check the water for any particles or mist. We take a glass filled with water and hold it up to the light where the red, orange or brown particles may be due to rusty or old equipment or pipes. Black parts inside the water can indicate that the pipes are starting to deteriorate.

Smell – Checking the water from the source for pollution will help in its smell so for such an analysis, where it should be easy to smell so now we smell the water. If it is bleach colored, it is most likely due to the chlorine that has been added to make the water safe. It is not harmful but it is a good idea to get a filter to remove the smell. Earthy or musty smells indicate that there is something organic in the water or in the drain and it is breaking down. If it smells like rotten eggs, it means there are bacteria growing in the water. Let the water sit in a glass for a few minutes and smell it again. If it doesn't smell like rotten eggs, it means the bacteria are inside the drain and not in the water.

Taste – In general, the analysis of well water for taste can only be done if it is transparent and has no foreign smell. At the same time, it is not necessary to swallow it, but it is enough just to absorb a little in the mouth. Now it is time to use our sense of taste, so if it tastes bad, we immediately remove the water. A metallic taste can mean that the pH levels are low or that there are excess minerals in the water supply, which is usually due to a rusty pipe. If it tastes sour, it means there are chemicals, which can be caused by industrial waste.

DETERMINATION OF PHYSICAL AND CHEMICAL PARAMETERS OF WATER

The level of many inorganic and organic elements in water is affected by various factors such as soil, rocks, minerals and pollutants that are in contact with the water. A water pollutant is a substance that is present in the environment in higher concentrations than its natural level, where its high level comes as a result of human, agricultural, livestock activities, etc. This represents a significant risk to the environment and public health [Notes from the archives…].

Determination of pH – the pH value is the negative calculation of the concentration of hydrogen ions, where it is expressed as:

$$\mathrm{pH} = -\log \text{ as } \mathrm{pH} = -\log \mathrm{H}+ \tag{1}$$

For chemically clean water at a temperature of 25 °C:

$$\mathrm{pH} = -\log 14 - 7 = 7 \tag{2}$$

If we have a higher concentration of H+ ions in the water, the pH will be less than 7, it means that the water has acidic properties, and if there are more OH^- ions in the water, then the pH will be greater than 7 and water will have basic properties.

Determination of temperature – water temperature also plays an important role in the solubility of O_2 and other gases in river water, so it must be measured. Depending on the existing temperature of the river water (and other factors), the situation with the amount of dissolved oxygen and other gases – aquatic life – appears. Temperature and conductivity were measured with the same equipment that measured pH, but other probes were placed and by means of the Mode button we changed the parameter we wanted to measure.

Determination of electrical conductivity – depending on the charge of mineral salts and their composition, salts of organic compounds are weaker conductors, while salts of inorganic compounds have much higher electrical conductivity. The conductivity of the electric current is caused by various salts dissolved in water, acids, bases that we call electrolyte with one name. As a specific unit, the conductivity of the aqueous solution of the electrolyte with a surface of 1 cm^2 is taken. As a unit of measurement of specific electrical conductivity is Microsimens per centimeter. Chemically pure water has a very low electrical conductivity.

Determination of turbidity – water turbidity comes from suspended matter where suspended matter originates from clay, iron and sometimes from industrial materials – waste. In Pristina Waterworks, the turbidity is determined digitally through a device called a Turbidimeter, where the unit of turbidity is NTU.

Determination of free active chlorine – free active chlorine (residual chlorine) is the amount of chlorine that remains without reacting with organic matter. The bound active chlorine is determined in the laboratory: in 5 (five) water samples of one liter, the amount of chlorine with a known concentration of 0.3, 0.6, 0.9, 1.2, 1.5 mg/l is added. After 20 min. the amount of chlorine is controlled with orthotolidin or with DPD. If there is no free active chlorine in any sample, then the amount of bound chlorine is greater than 1.5 mg/l.

Example: in the first three bottles no free chlorine was found, in the fourth 0.1 in the fifth 0.5, then the amount of active chlorine bound is:

$$A = \frac{(1.2 - 0.1) + (1.5 - 0.5)}{2} = \frac{1.05ml}{l} \quad (3)$$

With this method, the necessary amount of chlorine is determined, in order to avoid an excessive dose in the water. For complete and efficient disinfection, a quantity of free active chlorine must always be provided which remains after water disinfection.

Determination of $KMnO_4$ consumption – in a 300 ml Erlenmeyer flask, pour 10 ml of water to be analyzed, 5 ml of sulfuric acid diluted 1:3 and heat up to volume. Then 15 ml of $KMnO_4$ n/100 are added and heated for another 10 min. If the color disappears earlier, it is a sign that all the permanganate has been consumed.

In this case, the smallest amount of water must be taken for analysis (10, 15 and 20 ml) and the same procedure is followed. If after heating with $KMnO_4$ the color does not lose even after 10 min. the Erlenmeyer flask is removed from the well and 15 ml of oxalic acid are added with a pipette where the sample then loses its color, then this sample is titrated with $KMnO_4$ until the pale pink color appears and the appearance of this color begins only after 14 hours. Then we calculate the expenditure of $KMnO_4$ through the formula:

$$\text{The expense of } KMnO_4 = XmlKMnO_4 - \\ - 0.002\ mol/dm^3\ xf(faktori) \quad (4)$$

Where the spent milliliters of $KMnO_4$ is multiplied by the factor 0.3225 taken from the table. For example, If the expenditure of $KMnO_4$ is 1.3, then we have:

$$1.3 + 15\ (\text{amount of } KMnO_4) = \\ = 16.3 - 14.7\ (\text{titer}) = 1.6 \times 0.3225\ (\text{factor}) = \\ = 5.15\ (\text{spend of } KMnO_4) \quad (5)$$

Determination of nitrites – in 100 ml of sample water, add 2 ml of sulfonic acid and mix well. After 5 minutes, add 2 ml of alpha naphthyl amine solution and let it stand for 10–15 minutes and compare it with the standard solution. The presence of nitrites can also be observed by eye because if there is a large amount present, the solution will be cloudy after standing for 15 minutes. The allowed amount of nitrites in water is up to 0.005 mg/l. The determination of nitrites was also done by means of a spectrophotometer.

Determination of nitrates – pour 1 ml of sample water for analysis into the test tubes and add 2 ml of concentrated sulfuric acid and 6–8 drops of brucine solution, mix once and cool. The presence of nitrates can also be seen with the naked eye. The presence of nitrates gives the liquid a red color, which turns yellow after a while. Now we determine the presence of nitrates more accurately and faster with the spectrophotometric method.

Ammonia determination – we take a 50 ml measuring cup and fill it with sample water and add the composition of an ascorbic acid tablet and mix until dissolved, then add the composition of the reagent Aluver 3 Aluminum tablet and mix until dissolved. Separate 25 ml of sample water from the beaker and place it in the cuvette, add the contents of a reagent to remove the color, and separate with the remaining 25 ml in the beaker for 30 seconds. When we add this reagent to the solution for removing the color, it still remains in light orange, we empty these 25 ml into the cuvette and use it as zero. The reaction time is 15 min. After 15 min we read the values of the analysis sample which are expressed in milligrams per liter mg/L as Al3+. If the water sample for analysis shows a red to orange color, then it can be seen that aluminum is present in the water, so there is aluminum in the water.

Determination of chlorides – for the determination of chlorides, 100 ml of sample is taken. Raw samples of drinking water at pH 7–10 are titrated without pretreatment. We put 100 ml of water sample in a beaker and add 1 ml of Potassium Chromate ($K2CrO_4$), then titrate with $AgNO_3$ (silver nitrate), until a deep red color appears (the color of rotten meat). The titration is performed with a pipette and the spent milliliters are read, where these milliliters are then multiplied by the number 10 and this gives us the value of chlorides in the water.

For example:

$$1.3 \times 10 = 13\ mg/l\ chloride \quad (6)$$

RESULTS OF ORGANOLEPTIC AND PHYSICO-CHEMICAL ANALYSES

During the research-scientific work, the organoleptic and physico-chemical parameters for the quality of drinking water were determined, the results of which were compared with the reference values of Directive 98/83/EC for drinking water, Table 1.

Now we see Tables 2, 3 and 4 where the results of the analyzes carried out for the organoleptic and physico-chemical parameters for three consecutive days are presented.

In the water supply, chlorine is used during the water treatment process where we have no reason to determine it in the processed water samples. As for nitrites and nitrates, they are determined twice a day.

DISCUSSION OF RESULTS

In the part of the experimental work, during the drafting of this work, a total of 23 water samples were taken from Batllava lake and Badoc lake and from some wells in Pristina in the Pristina water supply. From the obtained results, the assessment of the state of the quality of raw water and water treated for use by consumers was made, and as the basic reference value, those arising from Directive 98/83/EC on the quality of water intended for consumption were taken human. Regarding the organo-leptic aspect, the water was in normal conditions, both in the raw water and in the processed water. On the first day in the raw water, the turbidity

Table 1. Reference values according to Direc.98/83/EC

Settings	Unit	Reference Values Direc.98/83/EC
Free chlorine (Rezidual)	mg/l	0.2–0.5
Turbidity	NTU	1.2–2.4
Color	-	not
Smell	-	not
Taste	-	not
The value of pH	-	6.5–8.5
The temperature	℃	8–12
Nitrites	mg/L	0,005
Nitrates	mg/L	10
Ammonia	mg/L	not
Electrical conductivity	μS /cm^2	1500
Chlorides	mg/L	200
Expenditure of $KMnO_4$	mg/L	8–12

Table 2. Results of organoleptic and physico-chemical analyzes of the first day

Settings	Raw water				Water in tank (treated)			
Analysis time	8	13	18	20	8	13	18	20
The Temperature (℃)	11.3	11	11.5	11.3	11.6	12.1	12.0	11.9
Smell (-)	not	not	not	not	not	not	not	not
Taste (-)	not	not	not	not	not	not	not	not
Turbidity (NTU)	2.8	2.6	3.1	3.3	0.42	0.40	0.41	0.41
Color (-)	not	not	not	not	not	not	not	not
The value of pH (-)	8.05	8.2	8.1	8.15	7.95	7.97	7.98	8.04
Expenditure of $KMnO_4$ (mg/L)	4.25	3.93	3.92	4.25	3.92	3.59	3.59	3.59
Free Chlorine (mg/L)	*	*	*	*	0.4	0.4	0.6	0.6
Chlorides (mg/L)	14	*	*	*	14	*	*	*
Ammonia (mg/L)	-	-	-	-	-	-	-	-
Nitrates (mg/L)	+	*	+	*	+	*	+	*
Nitrites (mg/L)	0.001	*	0.001	*	0.001	*	0.001	*
Electrical conductivity (μS/cm)	392	247	271	247	405	271	284	274

Note: + present; - are not present; * analyzes have not been performed.

Table 3. Results of organoleptic and physico-chemical analyzes of the second day

Settings	Raw water			Water in tank (treated)		
Analysis time	8	13	18	8	13	18
The Temperature (℃)	11.6	11.6	11.5	12.7	12.2	12.2
Smell (-)	not	not	not	not	not	not
Taste (-)	not	not	not	not	not	not
Turbidity (NTU)	2.9	2.7	2.9	0.44	0.49	0.39
Color (-)	not	not	not	not	not	not
The value of pH (-)	8.05	8.8	8.7	8.02	7.99	7.94
Expenditure of $KMnO_4$ (mg/L)	10.46	4.25	3.92	4.25	3.59	3.59
Free Chlorine (mg/L)	*	*	*	0.2	0.4	0.3
Chlorides (mg/L)	13	-	-	13	-	-
Ammonia (mg/L)	-	-	-	-	-	-
Nitrates (mg/L)	+	-	+	+	-	+
Nitrites (mg/L)	0.001	*	0.001	0.001	*	0.001
Electrical conductivity (μS/cm)	395	242	235	400	287	279

Note: + present; - are not present; * analyzes have not been performed.

Table 4. Results of the organoleptic and physico-chemical analyzes of the third day

Settings	Raw water				Water in tank (treated)			
Analysis time	8	13	18	20	8	13	18	20
The temperature (℃)	12.4	12.1	12.0	11.5	12.8	12.3	12.4	11.7
Smell (-)	not	not	not	not	not	not	not	not
Taste (-)	not	not	not	not	not	not	not	not
Turbidity (NTU)	2.2	2.2	2.5	2.5	0.35	0.34	0.35	0.36
Color (-)	not	not	not	not	not	not	not	not
The value of pH (-)	7.81	8.04	8.06	8.04	7.89	8.02	7.96	7.93
Expenditure of $KMnO_4$ (mg/L)	4.54	4.87	4.87	4.54	5.19	4.54	4.54	4.22
Free chlorine (mg/L)	*	*	*	*	0.2	0.3	0.4	0.4
Chlorides (mg/L)	13	*	*	*	14	*	*	*
Ammonia (mg/L)	-	-	-	-	-	-	-	-
Nitrates (mg/L)	+	*	+	*	+	*	+	*
Nitrites (mg/L)	0.001	*	0.001	*	0.001	*	0.001	*
Electrical conductivity (μS/cm)	329	382	244	250	258	288	245	243

Note: + present; - are not present; * analyzes have not been performed.

slightly exceeded the permitted limits, as stated above due to the presence of organic matter in the water or suspended particles, while all other parameters are good. As for the processed water, all parameters are within the allowed limits, except for free chlorine, but this is not an alarming or worrying value. On the second day, in the raw water, the turbidity slightly exceeded the reference values, while the expenditure of $KMnO_4$ is below the reference values three rare days. It is scientifically known that as a result of the higher presence of organic matter in water, more potassium permanganate ($KMnO_4$) is spent for their oxidation, the value of this parameter on the third day is higher than on the first and second day. In the processed water, analyzed in this research, all parameters are within the allowed limits.

On the third day of analysis, all the organoleptic but also physico-chemical parameters in raw and processed water have good values and in accordance with the reference values. However, the temperature and turbidity of raw water exceed the reference value in very small amounts, in the case of temperature this happens due to the weather and in the case of turbidity due to the very small presence of organic matter or suspended particles in water.

CONCLUSION

Water is a very important resource for the development of all organisms, including humans. The human factor is constantly degrading nature, which leads to the difficulty of his life. The care for water should be maximum since it is an essential factor for the development of human activity and his health. The continuous and uncontrollable use of artificial fertilizers and pesticides, the poor management of waste lead us to the pollution of this source that until now we have called as safe for drinking. Based on this research, from the results obtained during the laboratory work in the Prishtina Waterworks, the parameters show that the water quality is quite good in both cases, both in the raw water and in the processed water, and without a doubt that the best quality it is in the treated water, this water which then supplies all residents the Regional Water Company "Prishtina" - the joint stock company that includes the provision of services in the municipalities; Prishtin, Fushe Kosoven, Obiliq, Shtime, Lipjan, Podujevë, Drenas, Graqanicëd, Regional Water Company "Prishtina" is the largest water company in Kosovo. Drinking water and wastewater services are provided to about 40% of the population of Kosovo. So the water in both cases is in accordance with the reference values of Directive 98/83/EC for the quality of water intended for human consumption.

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