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Evaluation of Drinking Water Quality in Pogradec District

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Abstract: Supplying quality safe drinking water is a key factor for human health, a fundamental human right and an important component of effective health protection policies. In some regions of our country, investments in water supply and sanitation are lacking, affecting people's health. In this study, we have determined the quality of drinking water in Pogradec district, through organoleptic testing, physicochemical properties and bacteriological indicators, total coliforms and *Escherichia coli*. In this study are analyzed water samples, during each season of 2018, taken from Progrdec city and village piped system, in a natural recourse and private wells, which people use for water supply. Analyzes have been compared to drinking water rates according to the World Water Organization (WHO). The data obtained shows that the water supply in the city is clean and recommended for drinking and other personal needs. Organoleptic parameters are normal, physicochemical and bacteriological properties are in the limits recommended by WHO. Except in some cases where the parameters are not normal, there was a network fault, but immediate measures were taken to resolve the problem. In private wells, only one of the three was contaminated with total coliform and *E. coli*. This is because the well was not built under the right conditions. We recommend investing in the city and village water supply network and disinfecting them regularly. Also, private wells should be well maintained and disinfected. We also need to be careful with soil fertilization, because it affects groundwater pollution.

Keywords: Water supply, Well, Total coliforms, *Escherichia coli*

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Introduction

Drinking water quality parameters are often the most important tools for measuring access to improved water sources. The drinking water with an acceptable quality shows the water safety in terms of its physical, chemical and bacteriological parameters (WHO, 2004). Some of the attributes, including color, turbidity, odor, hardness, etc, are substantially influenced by the acceptability of drinking water (Addisie, 2012). Having a good knowledge of the factors that influence public perception can help improve water management, consumer services, the acceptance of water reuse and risk communication, among other areas (Doria *et al.*, 2009). Therefore, consumer perceptions and aesthetic criteria need to be considered in assessment of drinking water supplies even if they may not adversely affect human health (WHO, 2004). Safety is increased if multiple barriers are in place, including protection of water resources, proper selection and operation of a series of treatment steps and management of distribution systems (piped or otherwise) to maintain and protect treated water quality. The great majority of evident water-related health problems are the result of microbial (bacteriological, viral, protozoan or other biological) contamination. Cases with infections caused by contact or consumption of contaminated water with pathogenic bacteria such as *Escherichia coli* have been reported from different parts of the world, often causing the epidemic leading to death (Angulo *et al*., 1997).

Monitoring for the presence of pathogenic bacteria is a fundamental issue of water quality assessment, where direct or indirect use leads to serious human health problems (Chapman, 1992). According to WHO (2004), about 80% of all diseases and over 1/3 of deaths in developing countries are caused by contaminated drinking water. According to the previous studies (Osmani *et al*., 2019) the situation of water supply infrastructure in Albania is in a critical state as a result of economic problems. In some regions of our country, investments in water supply and sanitation are lacking, affecting people's health. People, who have opened wells to satisfy their needs, didn't analyze the water quality. Accurate data on this process are not available; however, two international NGOs have done basic surveys in rural areas where piped systems were absent (PIA, 2001).

In this study, we have determined the quality of drinking water in Pogradec district, through organoleptic testing, physicochemical properties and bacteriological indicators, total coliforms and *Escherichia coli*. In this study are analyzed water samples, during each season of 2018, taken from Progrodec city and village piped system, in a natural recourse and private wells, which people use for water supply. Analyzes have been compared to drinking water rates according to the World Water Organization (WHO) 2008.

Method

Area of the Study

The city of Pogradec was built on the southwestern shores of Lake Ohrid and is one of the most notable cities of Albania for its tradition in hosting "family tourism" and for the pleasant, fresh climate during the summer season.

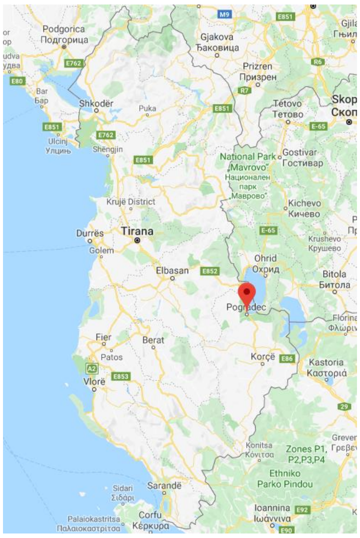

Figure 1. Map of Albania and the Pogradec city

The tectonic lake is four million years old and is the deepest of its kind in the Balkans**,** reaching a maximum depth of 285 meters. The lake environment is a natural habitat for a variety of old flora and fauna. It houses the rare fish “Koran,” a kind of trout, impossible to find in almost any other lake in the world. Lake Ohrid is part of the Natural and Cultural Heritage List of UNESCO (Basler, 2000).

Sample Collection and Analysis

Water samples are taken in every season during 2018. In the Pogradec city are taken eight samples in the network and in the village are taken eleven samples; seven in network, one in natural recourse and three in private wells. In the table 1 are given the places where are collected the sample.

Table 1. The places of water samples in Pogradec city and village

No	Pogradec city	Village
1	Turizmi	Depozita
2	Kala	Lagje
3	Rruga Naim Frashëri	Cërravë
4	Spitali	Zërvaskë
5	Vërdova	Guras
6	Axhensia	Bucimas
7	1 Maji	Natural recourse
8	Dëshmorëve	Private wells 1
9		Private wells 2
10		Private wells 3

Water samples were taken according to WHO (1997). Water samples for bacteriological analysis were obtained via 250 ml sterile bottles, where the date and place of sampling was noted. In natural resources, water samples were taken holding the bottle by the lower part; submerge it to a depth of about 20 cm, with the mouth facing slightly upwards. While in wells and pipes, we have turn on the tap at maximum flow and let the water run for 1-2 minutes. While holding the cap and protective cover face downwards (to prevent entry of dust, which may contaminate the sample), immediately we have hold the bottle under the water jet, and fill.

(a) (b)

Figure 2. Water sample collection (a) piped system and (b) private well

The collected drinking water samples have been tested in the regional laboratory of Health directory in Pogradec.

Organoleptic parameters

Color. Transparency (visibility) of water is a measure of depth of penetration of light. This parameter depends on the presence of coloring matter and turbidity due to suspended matter. Color of water (hue) can be due to organic or inorganic contaminants. It can also be pH-dependent. Color of water, free from suspended matter, can be estimated semi-quantitatively by comparing samples with standard solutions of potassium chromate of different dilutions.

Odor and Taste. Odor and taste determinations are qualitative and subjective. In addition to chemical and biological effects of foul smelling and coloring constituents, they make the water aesthetically unacceptable. Odor in water is a general sign of pollution by decaying organic matter. Compounds that contribute to odor are generally volatile organic compounds, while chemicals that contribute to taste and odor are ketones, phenols, aldehydes and some other organic and inorganic compounds (Bitton, 2005).

Physicochemical properties

pH is dertermined according to BS EN ISO 10523:2012, with electrode. The potential of the measuring electrode is a function of the hydrogen ion activity of the measuring solution.
Chlorine (Cl) The quickest and simplest method for testing for chlorine residual is the DPD (diethyl paraphenylene diamine) indicator test, using a comparator. A tablet of DPD is added to a sample of water, colouring it red. The strength of colour is measured against standard colours on a chart to determine the chlorine concentration. The stronger the colour, the higher the concentration of chlorine in the water.
Nitrite (NO_2^-) is determined according to EN 26777:2006 by spectrophotometer.
Amonia (NH_3) is determined according to ISO 7150/1:1984 by spectrophotometer with Nessler reagent (mixing K_2HgI_4, NaOH or KOH).

Bacteriological properties

The membrane filtration method, ISO 9308-1 (2002) was used for the detection and enumeration of *Escherichia coli* and total coliform bacteria in water for human consumption.

Results and Discussion

Organoleptic Parameters

The standards that establish water's quality criteria for human consumption include organoleptic analysis. Organoleptic analysis of water are related to odor, taste and color. If the water has an unusual taste or smell (or it is cloudy or colored), it can be interpreted as a health risk and a problem in the water source, its treatment, or in the water network. Transparency of water is related to coloring materials and turbidity due to suspended and colloidal matter. Certain inorganic as well as organic compounds change the organoleptic properties of water or even make it unfit for human or industrial uses.

Table 2. Organoleptic properties in water sample from Pogradec city

No	Water sample	Spring			Summer			Autumn			Winter		
		Color	Odor	Taste	Color	Odor	Taste	Color	Odor	Taste	Color	Odor	Taste
1	Turizmi	N	N	N	N	N	N	N	N	N	N	N	N
2	Kala	N	N	N	N	N	N	N	N	N	N	N	N
3	Rruga Naim Frashëri	N	N	N	N	N	N	N	N	N	N	N	N
4	Spitali	N	N	N	N	N	N	N	N	N	N	N	N
5	Vërdova	N	N	N	No	No	N	N	N	N	N	N	N
6	Axhensia	N	N	N	N	N	N	N	N	N	N	N	N
7	1 Maji	N	N	N	N	N	N	N	N	N	N	N	N
8	Dëshmorët	N	N	N	N	N	N	N	N	N	N	N	N
9	WHO, 2008	N	N	N	N	N	N	N	N	N	N	N	N

N-Normal

No- No normal

According to WHO (2008) pure (normal) drinking water, it should have no color, odor and taste. In all water samples in the city the organoleptic characteristics are normal, with the exception of the sample taken in Vërdova. Where during the summer season abnormal values in appearance and odorles have occurred. According to the residents supplied by this water network, they found that the water was not translucent (it was brown) and had odorles. Then, they informed the local government who had noticed a pipeline rupture. Immediately measures were taken to regulate it and the water returned to normal.

In the village water supply, except for the samples taken in Zërvaskë and Guras, the values are according to WHO (2008). In these two places, as a result of the amortization of the water pipes, the pipe was damage. This has caused the odor of water. Measures have been taken by the local government to solve the problem.

Table 3. Organoleptic properties in water sample from village

No	Water sample	Spring			Summer			Autumn			Winter		
		Color	Odor	Taste	Color	Odor	Taste	Color	Odor	Taste	Color	Odor	Taste
1	Depozita	N	N	N	N	N	N	N	N	N	N	N	N
2	Lagje	N	N	N	N	N	N	N	N	N	N	N	N
3	Cërravë	N	N	N	N	N	N	N	N	N	N	N	N
4	Zërvaskë	N	No	N	N	N	N	N	N	N	N	N	N
5	Guras	N	No	N	N	N	N	N	N	N	N	N	N
6	Bucimas	N	N	N	N	N	N	N	N	N	N	N	N
7	Natural recourse	N	N	N	N	N	N	N	N	N	N	N	N
8	Private wells 1	N	N	N	No	No	No	N	N	N	N	N	N
9	Private wells 2	N	N	N	N	N	N	N	N	N	N	N	N
10	Private wells 3	N	N	N	N	N	N	N	N	N	N	N	N
9	**WHO, 2008**	N	N	N	N	N	N	N	N	N	N	N	N

N-Normal
No-No normal

In Table 3, from the analysis of the three private wells, it was found that only one, during the summer season, had color, odor and taste. The water of this well was contaminated. Soil fertilization with compost and livestock compost, decreased rainfall and soil irrigation (as a result of high temperatures in summer) have affected the composition of the compounds along with the water in the well water. Also, this well was very old and was not built according to the standards of construction.

Physicochemical Properties

However, WHO (2008) recommends that public water systems maintain pH levels of between 8.2 and 8.8, a good guide for individual well owners. Water with a low pH can be acidic, naturally soft and corrosive. Acidic water can leach metals from pipes and fixtures, such as copper, lead and zinc. It can also damage metal pipes and cause aesthetic problems, such as a metallic or sour taste, laundry staining or blue-green stains in sinks and drains. Water with a low pH may contain metals in addition to the before-mentioned copper, lead and zinc. Drinking water with a pH level above 8.8 indicates that a high level of alkalinity minerals are present. High alkalinity does not pose a health risk, but can cause aesthetic problems, such as an alkali taste to the water that makes coffee taste bitter; scale build-up in plumbing; and lowered efficiency of electric water heaters. İn our study the pH was in the limits of WHO (2008).

Many of the diseases that affect traumatized communities are caused by micro-organisms carried in drinking-water. Hence the reference to water-borne diseases. Disinfection is the process of destroying these organisms to prevent infection. There are a number of methods of disinfecting water, but chlorination is by far the most common. According to WHO in 2008 Guidelines, based on taste considerations, a guideline value of 5 mg/l was established for chlorine. Chloramination may give rise to the formation of nitrite within the distribution system, and the concentration of nitrite may increase as the water moves towards the extremities of the system (WHO, 2011). İn our study chlorine was below the limit in the city figure 3 and village samples figure 4.

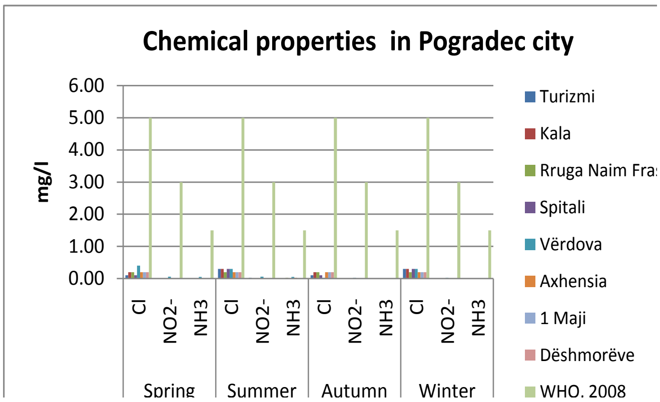

Figure 3. Chemical properties in water sample from Pogradec city

Nitrites are part of the nitrogen cycle, that is the transformations of nitrogen and nitrogen containing compounds in nature. While nitrites alone do not signify a pollution problem, their presence in combination with ammonia and nitrate may indicate environmental contamination. Nitrites can enter water through the use of corrosion inhibitors in industrial process water, or through the conversion from ammonia or nitrates. Nitrite can also be formed chemically in distribution pipes by *Nitrosomonas* bacteria during stagnation of nitrate-containing and oxygen-poor drinking-water in galvanized steel pipes or if chloramination is used to provide a residual disinfectant and the process is not sufficiently well controlled (WHO, 2011). In our study nitrites are under the limits of WHO (2008) 3 mg/l.

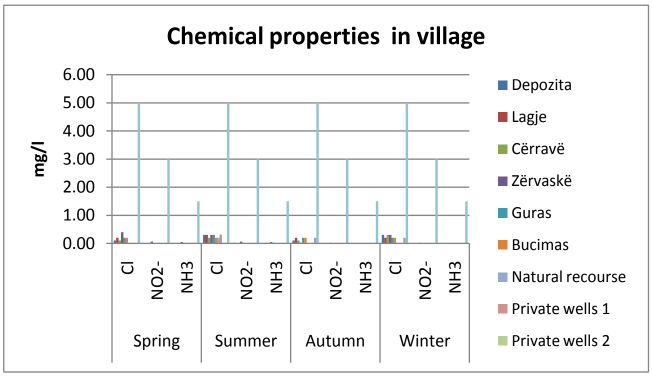

Figure 4. Chemical properties in water sample from village

Natural levels in groundwaters are usually below 0.2 mg of ammonia per litre. Higher natural contents (up to 3 mg/litre) are found in strata rich in humic substances or iron or in forests (Dieter & Möller, 1991). Ammonia may be present in drinking-water as a result of disinfection with chloramines. The presence of ammonia at higher than geogenic levels is an important indicator of faecal pollution (ISO, 1986). Taste and odour problems as well as decreased disinfection efficiency are to be expected if drinking-water containing more than 0.2 mg of ammonia per litre is chlorinated, as up to 68% of the chlorine may react with the ammonia and become unavailable for disinfection (Wendlandt, 1988). In our study the ammonia under the limit of WHO (2008) 1.5 mg/l.

Bacteriological Properties

Dirty and polluted water can contain many harmful organisms including pathogenic bacteria, which cause diseases like cholera, bacillary dysentery, typhoid, and diarrhea. Disinfection of water aims to kill these pathogens without leaving any harmful chemical substances in the water. Coliform bacteria, thermotolerant (faecal) coliforms and Escherichia coli have for almost a century been used as indicators of the bacterial safety of drinking water (Osmani *et al*., 2019). Water quality guidelines state that drinking water must not contain waterborne pathogens. More specifically, *Escherichia coli* or total coliforms should not be present in any 100 ml sample of drinking water (WHO, 2008).

Table 3. Bacteriological properties in water sample from Pogradec city

No	Water sample	Spring		Summer		Autumn		Winter	
		Total coliform	*E. coli*	Total coliform	*E. coli*	Total coliform	*E. coli*	Total coliform	*E. coli*
1	Turizmi	0	0	0	0	0	0	0	0
2	Kala	0	0	0	0	0	0	0	0
3	Rruga Naim Frashëri	0	0	0	0	0	0	0	0
4	Spitali	0	0	0	0	0	0	0	0
5	Vërdova	0	0	0	0	0	0	0	0
6	Axhensia	0	0	0	0	0	0	0	0
7	1 Maji	0	0	0	0	0	0	0	0
8	Dëshmorët	0	0	0	0	0	0	0	0
9	WHO, 2008	0 / 100 ml							

The water in city is not contaminated with pathogenic bacteria, because all the water saples have 0 total coliform/100 ml water and 0 E. coli/100 ml water . This as a result of regular disinfection and the investments made in network. İt is recommended for drinking water and other needs.

Table 3. Bacteriological properties in water sample from village

No	Water sample	Spring		Summer		Autumn		Winter	
		Total coliform	*E. coli*	Total coliform	*E. coli*	Total coliform	*E. coli*	Total coliform	*E. coli*
1	Depozita	0	0	0	0	0	0	0	0
2	Lagje	0	0	0	0	0	0	0	0
3	Cërravë	0	0	0	0	0	0	0	0
4	Zërvaskë	0	0	0	0	0	0	0	0
5	Guras	0	0	0	0	0	0	0	0
6	Bucimas	0	0	0	0	0	0	0	0
7	Natural recourse	0	0	0	0	0	0	0	0
8	Private wells 1	0	10	0	2	0	0	0	0
9	Private wells 2	0	0	0	0	0	0	0	0
10	Private wells 3	0	0	0	0	0	0	0	0
11	WHO, 2008	0 /100ml							

Also in the village network, the water samples are not contaminated with pathogenic bacteria. Only the first private well is contaminated, because it has > 0 *E. coli*/ 100 ml water. So it is contaminated with *E. coli*. This pollution has come from over-utilization of livestock compost, fertilizers, pesticides etc., to increase the soil fertility. Inappropriate ways of irrigation and rainfall have affected the penetration of coliforms in the soil depths and underground water.

Conclusion

Based on the data obtained, we came to the conclusion that the water supply in the city is clean and recommended for drinking and other personal needs. Organo-leptic parameters are normal, both physico-chemical and bacteriological are within the limits recommended by WHO (2008). Except in some cases where the parameters are not normal, there was a network demage, but immediate measures were taken to resolve the problem.

Even in the village's water supply and natural recourse water is clean and recommended for drinking and personal use. Where the parameters studied are within the limits recommended by the WHO. In one of the private well, was contaminated with *Escherichia coli.* This is because the well was not built properly and was not insulated. This pollution has come from over-utilization of livestock compost, fertilizers, pesticides etc., to increase the soil fertility. Inappropriate ways of irrigation and rainfall have affected the penetration of coliforms in the soil depths and underground water.

Recommendations

Presently, rural water supply systems remain in desperate need of improvement, even though many of them are well beyond cost-effective repairs and interventions that are more painstaking should be considered. Should be paid attention to the investments in the development of the village's water supply with pipes (24 hours/day), investments in the sanitary sewer and their disinfection should be done regularly. The wells must fulfill the hygienic sanitary norms. Also, disproportionate use of livestock, fertilizers, pesticides etc., should be avoided. People need to be informed about the importance of ideal water supply and the impacts of water polluted have on their health.

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