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Professional paper

MONITORING OF SOME PARAMETERS OF QUALITY AND MICROBIOLOGICAL SAFETY IN DRINKING WATER

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Abstract

Knowing that the water used for drinking is the most important product in our life, but its greatest importance comes as a result of the fact that water is present in higher quantities in all food products. To establish the quality and safety of water, it undergoes a series of essential assessments including sensory, physical, chemical, and microbiological analyses within a laboratory setting. The monitoring of some parameters in this paper is important both in terms of quality and in particular that of microbiological safety, because the importance of the water like final product. The parameters that have been analyzed are: water temperature, pH scale, electrical conductivity, turbidity, general hardness and the total number of microorganisms. From the analyzes performed, the results were obtained: temperature 13ºC, electrical conductivity 208±0.1 μS/cm, pH 8.09±0.01, turbidity 0.2±0.1NTU, total hardness 3.2±0.1 ºdH and the amount of chlorine 0.2±0.1 mg/L. From the microbiological point of view, the water was found to be devoid of microorganisms. The culmination of these analyses provides us with a comprehensive understanding of the qualitative nature and microbiological safety of the examined parameters. This comprehensive overview offers valuable insights into the quality and safety of the water being studied.

Keywords: Water, hardness, turbidity, pH, electrical conductivity, chlorine, microbiological.

1. Introduction

The water, is a chemical compound with extraordinary characteristics and with fundamental importance for the environment. It has fundamental importance for life on Earth (Prepas et.al., 2001). Water is one of the prime elements responsible for life on earth as two thirds of earth's surface is covered by water. Ninety-seven percent of the world's water is found in Oceans. Only 2.5% of the world's water is non-saline fresh water (Itodo & Itodo, 2010). The term "drinking water quality" involves assessing the composition of water in relation to its impact from both natural processes and human activities. Challenges to drinking water quality stem from the introduction of chemical compounds into water supply systems due to leaks and cross-connections (Napacho & Manyele, 2010). Ensuring reliable access to safe and clean water is currently one of the greatest global challenges especially in Asia (Shahid et al., 2017). In terms of hygienic relevance, bacteria commonly found in water can be categorized into several groups: a) Saprophyte bacteria (genera: Pseudomonas, Achromobacter, Alkaligenes, Flavobacterium, Xantomonas, Serratia, Erwinia, Micrococcus, Sarcina, Vibrio and Bacillus); b) Opportunistic bacteria (Aerobacter aerogenes, Aerobacter liquefaciens, Aerobacter clocacae, Pseudomonas aeruginosa); c) Pathogenic bacteria (genera: Salmonella, shigella, Leptospira, Mycobacteriae, Vibio comman etc.) (Ferati et al., 2020). Treatment of drinking water by utilities has had a profound positive impact on public health by significantly reducing the risk of waterborne infections in areas served by these water supplies (Ford 2016). Despite its limitations, turbidity has been judged to be of sufficient relevance to be included in the drinking-water regulations of many developed countries. The U.S. rules surrounding turbidity (U.S. EPA 2015). Turbidity measurements for the purpose of monitoring filtration performance are generally taken using continuously operating, automated turbidimeters at each individual filter [as per U.S. EPA guidance (U.S. EPA 2004).

The measurement of turbidity through automated turbidimeters is known to be less precise, particularly at lower levels (Burlingame et al., 1998). Drinking water is not only consumed as a standalone beverage but also incorporated into various beverages and food products. In response to increasing global and local water scarcity, there is an increasing use of sources such as recovered/recycled water, harvested rainwater, and desalinated water. 884 million people lack access to safe water supplies; approximately one in eight people (UNICEF/WHO, 2008). The current investigation indicated that EC value ranged from 179.3–20 μS/cm with an average value of 192.14 μS/cm. Similar value was reported by Soylak et al. (2001) regarding drinking water in Turkey. Hardness generally enters groundwater as the water percolates through minerals containing calcium or magnesium. Common sources of hardness are limestone (introduing calcium) and dolomite (introducing magnesium Groundwater typically exhibits higher hardness due to this mechanism, compared to surface water (Prepas et al., 2001). The current investigation ranges were pH 6.52–6.83 which are in the range of WHO standards. The overall result indicates that the Wondo Genet College water source is within the desirable and suitable range. Basically, the pH is determined by the amount of dissolved carbon dioxide (CO2), which forms carbonic acid in water. Present investigation was similar with reports made by other researchers' study (Edimeh et al., 2011; Aremu et al., 2011). Chloride concentrations should not surpass 250 mg/L according to WHO standards. The chloride values in the study area ranged from 3 to 4.4 mg/L at Wondo Genet Campus, with a mean value of 3.7 mg/L. Similar results were documented by Soylak et al. (2001) for drinking water in Turkey. Even though the use of E. coli and enterococci for water quality monitoring has led to significant improvements in drinking-water safety, the use of these microbial indicators has serious shortcomings. These have been summarized as "too little and too late" (WHO/OECD, 2001). Water contaminated with bacteria is not fit for human consumption. Coliforms can be used as indicator to assess water microbiological quality (Nicholson et al., 2017) with rapid detection being essential for water quality evaluationVarious microbial contaminants such asCampylobacter spp., Yersinia spp., Escherichia coli, Pseudomonas aeruginosa, intestinal enterococci, Salmonella spp., Shigella spp., Bacillus spp., or Staphylococcus aureus have been previously detected in groundwater (Grisey et al., 2010; Pitkänen et al., 2011). The primary standard microbiological parameters currently used for the basic water quality assessment are *E. coli*, total coliforms, fecal coliforms, and intestinal enterococci (Rufino et al., 2021).

2. Materials and methods

Drinking water at the source was used as material for analysis. The work methodology started with taking water samples before treatment S1 and after the treatment process of chlorination, filtration and the treatment with UV rays S2. These analyses took place at the laboratory of the Faculty of Food Technology and Nutrition in Tetovo. Several physical and chemical parameters were analyzed in the samples, such as: temperature, electrical conductivity according to the MKC EN 27888:2007 method, pH value (according to the ISO 10523:2008 method), turbidity (measured using a HACH ISO7027:19
99 turbidimeter), residual chlorine (analyzed per the MKC ISO5667-5:2007 method) total hardness (using the standard method) and several microbiological parameters, Escherichia coli (in 100mL) by the ISO 9308-1 method, Enterococci MKC EN ISO1899-2:2009, Pseudomonas aeruginosa MKC EN ISO16266:2009, sulphite - reducing clostridia, total number of bacteria ISO 6222:2009, total coliform bacteria MKC ISO 9308-1:2010.

Figure 1. Water samples for analysis

3. Results and discussion

The average values obtained from the three measurements are summarized in Table 1. The temperature in the sample remained constant at 12°C±0.1 before and after chlorine treatment. the pH value as in sub-sample S_1 and sample S_2 resulted in the same values of 8.09±0.02 , electrical conductivity in sample S_1 resulted in a higher value of 208 ±0.1 mS/cm while in sample S_2 it had lower values of 200 ±0.1 mS/cm, turbidity in NTU in sample S_1 1.6 ±0.01 while in sample S_2 0.20±0.01, total hardness 18 ±0.1 in the S_1 sample, while 4 ±0.1 in the S_2 sample, while the residual chlorine in the S_1 sample was in higher and positive amounts, while after the treatment in the S_2 sample, the value was minimal 0.2 ±0.01 mg/L.

Table 1. Physical and chemical results in analyzed water samples

Analyzed parameters	**Water before treatment**	**Water after treatment**
Temperature (ºC)	12 ±0.1	12 ±0.1
pH	8.09±0.02	8.12±0.02
Electrical conductivity (mS/cm)	208 ±0.1	200 ±0.1
Turbidity (NTU)	1.60 ±0.01	0.20±0.01
Total hardness (°dH)	18 ±0.1	4 ±0.1
Residual chlorine (mg/L)	Positive	0.2 ±0.01

The results obtained in table 2 demonstrate the absence of *Escherichia coli*, *Enterococci*, Total number of coliform bacteria, Total number of coliform bacteria and *Pseudomonas aeruginosa*. So, chlorine treatment, filtration and UV treatment have had a positive impact as a technological process and the water is considered safe from a microbiological prespective for the analyzed parameters.

Table 1. Microbiological results in analyzed water samples

Analyzed parameters of water after treatment	**Results**
Escherichia coli (in 100mL)	*0 cfu/100mL*
Enterococci (in 100mL)	*0 cfu/100mL*
Pseudomonas aeruginosa ((in 100mL)	*0 cfu/100mL*
Total number of bacteria (37°C in 1mL)	*0 cfu/1mL*
Total number of coliform bacteria (in 100mL)	*0 cfu/100mL*

4. Conclusions

Based on the high results obtained from the analyses of water samples S1 and S2, it can be concluded that while the water quality at the source was initially good, the implementation of physical technological processes, including chlorine treatment and UV irradiation, led to a significant improvement in the water's quality and microbiological safety for drinking purposes.

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