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Determination of water quality in Hadim District of Konya (Turkey) and the investigation of disinfection efficiency

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Abstract

Drinking and usage water of Hadim Town (Konya, Turkey) has been provided from underground water. For this reason, there is no any treatment method but only disinfection with chlorine is applied. In the scope of this study, it is intended to determine the characteristic of the water quality via some analysing method of the drinking and usage water and to explore the effectiveness of the existing disinfection method which is applied at present. Water has been analysed collected 200 water samples from 5 points selected in the central district of Hadim water mains system. Subsequently, analyses, which are intended for characterizing the drinking and usage water of Hadim district, have been conducted both in the territory and in the public health laboratories of Konya province. Furthermore, analyses have been conducted in order to determine to what extent and at what point is effective the selected disinfection method (chlorination). Consequently, it has been determined that, on account of its chemical specialties, drinking water of the Hadim district is suitable for the standards stipulated for our country. Nevertheless, bacteriologically, it has been determined that the quality of the water is low owing to coinciding with coliform type bacteria from time to time.

1. Introduction

There is no doubt that water, which has a very important place in the life and life of people and other living things, is an indispensable substance. Early humans chose areas where they could easily obtain water and protect themselves easily to settle. Throughout history, civilizations have developed more in areas with water resources. In order to benefit from these waters better and more, they seized the resources and built dams and dams on the river beds. The fact that the surface waters, which are easy and cheap to use, cannot meet the needs and become polluted quickly, have led people to benefit from underground waters by making galleries, wells and drillings. Increasing population, rapidly developing industry and rapidly increasing number of factories have caused people to turn their attention to regions with low population density. People settle, process, set up facilities, etc. While searching for lands for various purposes, they aimed to find water in such regions first of all. This means that the surface waters in the distance are tunnels, canals, etc. It is possible by transporting the groundwater in various ways and bringing it to the surface by making it possible to transport it in very costly ways such as for this reason, the phrase "water is life" has not been said in vain [1].

Only less than 1% of the total amount of water on earth can be used as drinking water. Existing drinking water resources, increasing population, rapidly developing industry and disappearing natural environment limit underground and surface drinking water resources. While groundwater is generally directly drinkable, surface waters, streams, streams, lakes and dams are generally not of directly potable quality. Their chemical structures

mostly depend on the lands they pass through and on which they are located, on the nearby factories and settlements. Especially those close to large settlements are significantly polluted [2]. All water sources can be used both as drinking water and for industrial purposes. The natural water resources that are widely used in the industry by applying the appropriate treatment process are surface and underground waters. Despite this, it is expected that the ground waters that filter through a thick soil layer are cleaner than the surface waters, but the dissolved salt content is higher [3]. The best waters are spring waters, which are not sufficient in terms of quantity. Well water is also generally of good quality. However, these are not enough to meet the water needs of big cities. Therefore, river, stream and lake waters are used to meet the water needs. Such waters are sufficient in terms of quantity but not sufficient in terms of quality [4].

Sönmez [5], in his study, took samples in three different periods, in November-2002, April-2003 and August-2003, in order to examine the existing quality, pollution dimensions and sources of Incesu-Dokuzpınar underground cold-water sources and whether they comply with the standards. made analyses to reflect its quality and pollution status. As a result of the study, according to the Water Pollution Control Regulation of Dokuzpınar groundwater, in November I. It has seen that the class provides quality water values, but some parameters exceed the limits in April and August. In order to improve the water quality and maintain its usability as drinking water, it is recommended to provide training for the creation of protection areas around the source and for the local people to carry out their activities more consciously. The most important harm of organic matter accumulation is that it causes oxygen deficiency [6]. As a result of wastewater from factories related to agriculture and food and domestic discharges, they carry a large amount of organic substances to the aquatic environment [7].

Since the presence of pathogenic microorganisms that cause disease in drinking water is not continuous, it is not a sure and safe way to investigate them. Coliform bacteria and Escherichia coli are searched for because their search is difficult, requires a long time, and the chance of detecting these pathogens is not always high enough. In other words, in bacteriological water examination, “indicator” bacteria living in the intestines of humans and warm-blooded animals and mixed with faeces and polluted waters are investigated. These bacteria, which are an indicator of pollution, are called “coliform bacteria” [8]. The absence of coliform bacteria in a water indicates that it is clean, and the presence of more than a certain number indicates that it is dangerous. Although coliforms do not pose a great danger directly, they inform the danger [9].

It is aimed to disinfect drinking water by any method and to prevent the spread of infectious diseases that spread through water. Disinfection process is very important especially for public health. The most well-known disinfection process is chlorination. Chlorine and chlorine derivatives are the most commonly used disinfectants. Since the chlorine demand of a water may vary under the influence of other factors, the amount of chlorine for bacteria in the water should be measured with the orthotolidin test from time to time and the presence of colifrom bacteria should be checked [10]. The presence of E. coli in waters is a sign of the presence of harmful organisms. There are 108 – 109 E. coli in one gram of stool. For this reason, if E. coli is found when a drinking water source is analysed, it is understood that this source is contaminated with the faeces of humans, mammals and birds. The drinking water standard accepted for Turkey is the TSE TS 266 Drinking Water Standard and the Regulation on Water Intended for Human Consumption, which came into force after being published in the Official Gazette dated 17.02.2005 and Official numbered as 25730 [11].

This study is to determine the conformity of drinking and utility water quality to standards by examining some properties of drinking and utility water in the centre of Hadim district of Konya, which has a population of approximately 4000 people, in terms of chemical and bacteriological aspects. In addition, it is to investigate the effectiveness of the disinfection method used by the district municipality and used in the warehouses and distribution network and the disinfectant substance used in disinfection.

2. Material and Method

Hadim district center covers the drinking water network. On-site measurement and sampling points were selected according to the distribution of the areas covering the study area. At selected points, the physical, chemical and bacteriological parameters of the drinking water of Hadim district centre were measured both in the field and in the laboratory. Since Hadim district centre is small and accordingly the distribution network is short, it was deemed appropriate to choose 5 stations. For this reason, a total of 10 samples were taken, once a month for chemical analysis, and a total of 50 samples were taken from 5 points, once a month for bacteriological analyses, in order to monitor the quality changes in drinking water. In addition, in order to determine the residual chlorine ratio, a total of 200 samples were taken from 5 points, 4 times a month, once a week.

2.1. Study area

In this study, which was started on the basis of shopping centres located in Selçuklu district of Konya province, Hadim is one of the districts of Konya, located in the Central Anatolian region of our country, and is at the intersection of 37 degrees north parallel and 33 degrees east meridian in the northern hemisphere. Eunuch; It was established in a valley in the centre of the Central Taurus Mountains of Konya province, and its distance from Konya is 128 km. is at the same time, it falls within the borders of the Mediterranean region. Eunuch; It is in the

south of Konya. There is Karaman province in the east, Taşkent district in the south, Bozkır in the west and Alanya lands in the south-west of the district. The altitude of the district from sea level is 1500-1700 m [12].

Hadim drinking and utility water is supplied from Akdağ Spring in Akdağ location outside the district and Küçüksu spring in Gevne road junction area. The water coming from here is taken to various 6 collection areas in the district and collected in 3 main reservoirs that distribute to the network from here. While 15 L of water per second enters these tanks during the winter months, it drops to 8 L/sec in the summer months. Taşpınar meets the water needs of the district with its 370 m^3, Hocalar 110 m^3 and Lower hadim 90 m^3 reservoirs. Only chlorination is carried out in these warehouses, which distribute through network pipes made of PVC, cast iron and asbestos material. The physical, chemical and bacteriological properties of water are not known exactly, both at the source where it originates and at the points where it is used in Hadim district. It has been determined that there is no previous study based on analysis on this subject. The warnings made by the health institutions in certain periods against the fact that it is not bad in taste and smell cause some people to obtain drinking water from small sources in the environment or ready-made. For this reason, with this study, it is aimed to reveal the situation of drinking water, which is important for public health, in Hadim and to ensure that necessary precautions are taken [12].

2.2. Water Sampling Method

The standards of TS 266 Drinking Water, TS 5089 Water Quality-Sampling Part-1: TS 5090 Water Quality-Sampling Part-2: Sampling Techniques were complied with in the collection [11, 13, 14], transportation and preservation of the samples. Containers used for bacteriological analysis; Black, sterile and capped glass bottles were used. While taking the sample, the mouth of the faucet from which the water will be taken was sterilized by burning with a flame. Afterwards, the tap was opened to the end and flowed for a few minutes, and after making sure that the water representing the mains water came, the sample cups were rinsed with tap water and filled so that there was no air gap.

2.3. Organic Matter

Calcium and magnesium carbonate in the soil's composition turns into bicarbonate and dissolves in water. For this reason, there is more dissolved matter in the calcareous layers than in the previous ones. The excess of acids in the waters is formed by the decomposition of organic matter. Ammonia and iron are also high in waters passing through layers rich in organic matter. Generally, in places where water passes, chlorides, alkali sulphates, calcium and magnesium sulphates and their carbonates, iron and manganese compounds dissolve first, respectively. As the water passes underground, dissolved and soluble substances increase, and other substances gradually decrease with the filtering function of the ground. This is especially important for microbes. The water that passes through the layers that act as a good filter is cleaned from bacteria very quickly. Since the water passing through the cracks is not well filtered, it has not been purified by bacteria [15]. The water that evaporates into the air in nature is naturally clean when it is in the form of steam in the air. But this water rain, snow, etc. As it falls to the earth, it becomes more or less polluted according to the degree of pollution of the atmosphere by taking the gases, dust, fumes, radioactive sprinkles and microbes in the air layers. From the moment it comes into contact with the soil surface, its load begins to increase in terms of microorganisms, organic and inorganic substances, depending on the characteristics of these places. It also absorbs human, animal and plant organic wastes, agriculture, industry, sewage and nuclear pollution while flowing on the earth or passing into the depths [16].

The most important harm of organic matter accumulation is that it causes oxygen deficiency [6]. As a result of the deterioration and decomposition of aquatic flora and fauna, dissolved organic substances are mixed into the lake waters. However, these substances have been found in large quantities in the aquatic environment, especially as a result of the growth and development of industry and cities, and the increase in tourism. As a result of wastewater from factories related to agriculture and food and domestic discharges, they carry a large level of organic substances to the aquatic environment [7]. Organic materials can enter waters from a variety of sources, including humans, animals, and plants. Organic substances of plant origin are unimportant as they are not harmful. Those of animal origin are also transmitted to the water by birds, fish and aquatic animals. Of these, the most dangerous are organic substances contaminated by humans and other cattle. Especially in the waters that come into contact with places such as sewage cesspools, cemeteries, manures, barns, poultry houses, organic materials are high. Organic materials are relatively less in spring waters. The oxygen required to burn organic substances in one litter of water does not exceed 1.5 mg. When this figure is less than 1 mg, the water is considered chemically clean [16].

For Determination of Organic Matter, it is based on the oxidation of organic substances in water by using permanganate in an acid medium. The oxidation ability of water is expressed by the mg of potassium permanganate or the corresponding mg of oxygen consumed to oxidize the oxidisable substances in 1 litter of water. 100 mL sample is taken. 10 mL of dilute sulfuric acid solution and 10 mL of adjusted potassium permanganate solution are added and left in the water bath for 30 minutes (The sample is placed in the water bath so that the water level in the flask and the water level in the water bath are the same). The sample is removed from

the water bath and 10 mL of ammonium oxalate solution is immediately added. While it is hot, it is titrated with the adjusted potassium permanganate solution until a light pink is obtained. The result is found in mg of oxygen per litter.

2.4. Coliform and *E. coli* Determination

Drinking water is usually disinfected using chlorine or ozone. For disinfection to be successful, all pathogens must be exposed to the chemical disinfectant used. Most harmful organisms are exposed to disinfectant in turbid waters. However, in case of turbidity due to domestic wastewater solids, it is highly likely that harmful microorganisms can survive in the flocs. Therefore, excessive use of disinfectant is required. This is also expensive. For these and similar reasons, it is desirable to have very low turbidity values in water to be used as drinking water.

The 'Standard Methods' method was used in the search and counting of Coliform and E. coli bacteria from bacteriological analyses. Estimation Experiment, Confirmation Experiment, Completion Experiment were carried out. First of all, for the estimation experiment, 0.1 ml, 1 ml and 10 ml water samples were placed in three tubes with Lactose Broth medium containing Durhaim Tubes, and kept in an oven at 37 °C for 24/48 hours. If there is gas at the end of the waiting period, it is said that it can be Coliform, and if there is no gas, it is said that there is no Coliform. For the confirmation experiment, Brilliant Green-Laktose medium was cultivated. As a result of sowing, it is kept in an oven at 37 °C for 48 hours. If there is gas, it is said that there is coliform. If there is no gas, it is said that there is no coliform [17].

The presence of E. coli was tested for the completion assay. For this, EMB (Eosin-Methylene Agar) medium was cultivated and incubated in an oven at 37 °C for 24 hours. E. coli is said to be present or absent depending on whether it gives the metallic green colour or not. Counting coliforms; It is made according to the Most Probable Number (MPN) method in 100 ml. By diluting the sample at 10% rate 3 times, 3 tubes of 10 ml, 1 ml and 0.1 ml are prepared [17]. Sowing is done in these three prepared tubes. Reproductive results are evaluated according to the table below.

Table 1. Coliform bacteria count calculation according to the MPN method [17].

10 ml sample	1 ml sample	0,1 ml sample	Results MPC/100ml
+	+	+	>240
+	+	-	240
+	-	+	95
+	-	-	23
-	+	+	19
-	-	+	9
-	-	-	1>

2.5. Evaluation of residual chlorine analysis results

The first option for testing uses a liquid chemical OTO (orthotolidine) that causes a color change to yellow in the presence of total chlorine. You simply fill a tube with water, add 1-5 drops of the solution, and look for the colour change. These kits are sold in many stores as a way to test the concentration of total chlorine in swimming pool water. This method does not measure free chlorine. Whether you use chlorine gas or sodium hypochlorite to disinfect the wastewater, both have one thing in common – in solution they are reactive and very unstable. The chlorine wants to change from a high oxidizing level to a more stable reduced one. Because of this it is impossible to preserve a sample for residual chlorine. Any sample taken for residual chlorine analysis must be tested immediately. According to EPA, this means the sample must be tested within fifteen minutes of collection [18].

As a result of the analyses made, in the 3rd week of June, 1st and 2nd week of July, 3rd and 4th week of August, 4th week of September, 1st, 2nd and 3rd week of November, December, no chlorine was found in the mains water in January, February and March. In the 1st week of September, it was found only in the 1st sampling point, but not in the others. In the 2nd week of September, it was absent in the 1st sampling point, while it was found in the others. In the 3rd week of September, it was found in the 5th sampling point, but could not be found in other points. It was found in the first 4th sampling point in the 1st and 2nd week of October, but it could not be found in the 5th sampling point. The amount of chlorine required in the samples taken at all other points was determined. According to the results and as a result of the researches, the disinfection method in the mains water of Hadim district is carried out randomly and far from scientific techniques.

3. Results and Discussion

Some physical-chemical and bacteriological properties of drinking and utility water of Hadim district (district centre) were examined and sampling and analyses were carried out in a 10-month period in order to determine its quality. The results of the analysis of the samples taken from 5 sampling points determined in the study area were arranged separately for each month. Among the chemical analyses, pH, conductivity, total hardness, chloride and organic matter parameters were evaluated separately and their graphs were drawn. Bacteriological analyses were also evaluated separately. The residual chlorine parameter, which is used to control the disinfection, was evaluated alone. Organic Matter analysis results between June-2007 and March-2008 were evaluated. In the drinking water network of Hadim district centre, the results of the organic matter analysis made in the 10-month period were found even at low values in certain periods. While organic matter was not found in July, November, December and February, it was found at low rates in other months. However, since these values are below the normal values; The drinking water of Hadim District centre is at the desired drinking water quality level in terms of organic matter.

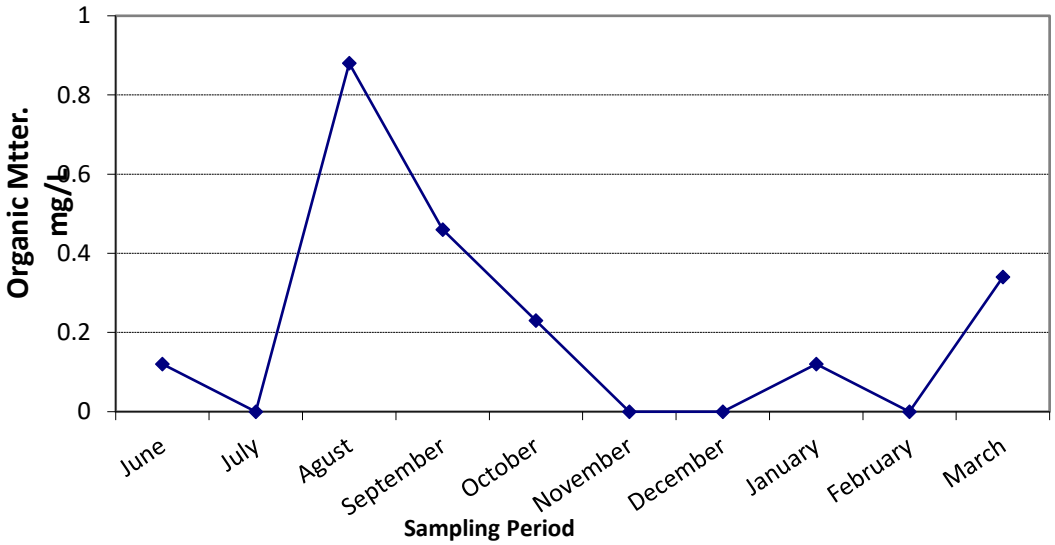

Figure 1. This is the example of table formatting

3.1. Bacteriological Analysis Results of Hadim Drinking Water Network Regarding Monthly E. Coli

The numbers of E. coli in 100 ml determined as a result of the bacteriological examination of the monthly water samples taken from 5 points are given in Table 2.

Table 1. *E. coli* results per 100 ml counted at points from June 2007 to March 2008

Sampling period	Sampling point-1 Prefecture	Sampling point-2 Central Pri. Sch.	Sampling point-3 Belediye Hotel	Sampling point-4 Hospital	point-5 A. Hadim Mosq
June	240 +*	240 +	240 +	240 +	240 +
July	240 -**	-	-	23	-
August	-	-	-	23 -	-
September	-	-	-	-	-
October	-	-	-	-	-
November	240 +	240 -	240 -	240 -	240 -
December	-	-	-	-	-
January	-	-	-	-	-
February	-	-	23 -	-	23 +
March	240 -	240	23+	23 +	240

* + sign indicates that reproduction continues; ** - sign indicates uraemia has stopped.

No bacteriological findings were found in the analyzes performed in September, October, December and January. In June and March, E. coli was found at all sampling points in the drinking water network. In the remaining months, while E. coli was detected at some points, it was not detected at some points. This suggests that the drinking water network was subsequently contaminated at some points. While the hospital point is the most polluted point bacteriologically, since five of the 10 measurements made, there is a pollution indicator, while the Central Primary School. point was determined as the cleanest point with 3 pollution indicators.

As a result of the analyzes made, in the 3rd week of June, 1st and 2nd week of July, 3rd and 4th week of August, 4th week of September, 1st, 2nd and 3rd week of November, December, no chlorine was found in the mains water in January, February and March. In the 1st week of September, it was found only in the 1st spot, but not in the others. In the 2nd week of September, it was absent in the 1st point, while it was found in the others. In the 3rd week of September, it was found in the 5th position, but could not be found in other points. It was found in the first 4 spots in the 1st and 2nd week of October, but it could not be found in the 5th spot. The amount of chlorine required in the samples taken at all other points was determined. According to the results and as a result of the researches, the disinfection method in the mains water of Hadim district is carried out randomly and far from scientific techniques.

4. Conclusions and Recommendations

microorganisms. Depending on the occurrence of this decomposition event in an oxygenated and anaerobic environment, various decomposition substances are formed. If this decay event occurs in an oxygenated environment, odourless decay occurs. Here, carbon dioxide from carbon, sulfuric acid from sulphur, nitrite and nitrate acids from nitrogen are formed [15]. Calcium and magnesium carbonate in the soil's composition turns into bicarbonate and dissolves in water. For this reason, there is more dissolved matter in the calcareous layers than in the previous ones. The excess of acids in the waters is formed by the decomposition of organic matter. Ammonia and iron are also high in waters passing through layers rich in organic matter. Generally, in places where water passes, chlorides, alkali sulphates, calcium and magnesium sulphates and their carbonates, iron and manganese compounds dissolve first, respectively. As the water passes underground, dissolved and soluble substances increase, and other substances gradually decrease with the filtering function of the ground. This is especially important for microbes. The water that passes through the layers that act as a good filter is cleaned from bacteria very quickly. Since the water passing through the cracks is not well filtered, it has not been purified by bacteria [15].

The importance of reliable and quality drinking water for public health is known by everyone. Providing a quality drinking water for use is possible by showing the necessary attention and sensitivity at every stage, from the quality of the water at the source, to the proper disinfection and treatment process, to the storage and distribution of the water. However, if necessary, attention is paid to these issues, drinking water can be safely offered to the use of consumers. Relevant public institutions have important duties in this regard. In the studies carried out, samples were taken from 5 points determined within a 10-month period of the drinking water of Hadim district, and the results obtained as a result of the analyses are given below:

While evaluating the mains water in Hadim as drinking water, the TS-266 drinking water standards in force in our country are taken as basis. Accordingly, it was determined in accordance with the standards in terms of chemical parameters. According to the results, it can be called 1st class water since it will be given to drinking water without any treatment other than disinfection. According to TS-266, while there should be 0 coliform bacteria in 100 ml, it is seen that this is not achieved in most of the samples. The presence of E. coli at some points in the samples taken on the same day indicates that there is wastewater leakage into the network. Coliform bacteria, which is an indicator of pollution, is another important parameter in terms of public health. The absence of coliform bacteria in a water indicates that it is clean, and the presence of more than a certain number indicates that it is dangerous. Although coliforms do not pose a great danger directly, they do signal danger. Accordingly, the health of the people who use tap water in some periods may be in danger. According to the results of the analysis and the presence of coliform bacteria in the network, the disinfection process is not performed properly and remains insufficient.

The absence of disinfection in warehouses and networks in December, January, February and March carries a great risk for the public. The presence of chlorine in the samples taken from the points in some weeks indicates that the disinfection was carried out irregularly and uncontrolled during the months. According to the results, it is understood that the current disinfection system used is insufficient and ineffective in terms of protecting the health of the public. We can list the reasons why many water samples taken from the mains could not meet the drinking water standards in terms of bacteriology as follows:

Water resources are dirty or polluted in the area where they originate. Disinfection (Chlorination) is not done in accordance with scientific techniques. Since the network is very old and not constructed properly, there is leakage into the drinking water pipes either from the sewerage or wastewater puddles.

5. Suggestions

Suggestions to be considered in order to improve the drinking and utility water quality of Hadim district are given following:

In accordance with the Water Pollution Control Regulation [19-21]; Class AGW I and Class UGW II group wells, springs and infiltration galleries, from which groundwater is taken, are used for drinking water supply, no structures, solid and liquid waste discharge and passage are allowed at distances closer than 50 meters. In order to achieve this, the surrounding of the sources, which are completely unprotected, is 50 m. surrounded by barbed wire. When necessary, a second protection band should be created and construction, agriculture and animal husbandry should not be allowed. The increase in cherries in recent years also brings some chemical pollution. For this reason, awareness raising studies should be carried out for agricultural activities carried out in places close to the source and suggestions should be made for the use of natural fertilizers. Otherwise, the deterioration of high-quality water will not be prevented. Disinfection should be done in accordance with scientific rules. The purpose of disinfection is the destruction of pathogenic organisms and the prevention of water-borne diseases. Success in disinfection with chlorine; It depends on the type, density, contact time of the microorganism, pH value of the water, temperature of the water, and the presence of organic matter in the water. For a good disinfection, the turbidity should be low. For this reason, all these factors should be taken into account when chlorinating the mains water. In normal times, the minimum initial dose of chlorine to be given is 1.0 mg/L. If ammonium ions are present in the water, 6 mg/L chlorine is needed for 1 mg/L NH4+. Studies have shown that 0.5–1 mg/L hypochlorous acid residue is effective for a contact time of 30 minutes [22]. Again, according to this information, the amount of chlorine added to the network is not always the same, and changes should be observed by observing. At least, chlorination doses should be adjusted by constantly monitoring ammonium ion analysis.

Persons responsible for disinfection application must be qualified and at least trained. Permanent staff should be assigned. Chemical, physical and bacteriological analyses should be done continuously and precautions to be taken for changes should be planned in advance. Urgent solutions should be sought for chlorination, which is not done in the face of freezing and excess water in winter. Necessary thermal insulation must be provided for the chlorinator. In addition, chlorination techniques should be investigated and a more effective technique and device suitable for the warehouse and network should be used. Extra new tanks should be made in order to remove chlorination and turbidity.

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Author contributions

Sukru Dursun: Conceptualization, Methodology, -Reviewing and Editing; **Abdurrahman Sarcan:** Investigation, Experimental work, Writing-Original draft preparation, Conclusion.

Conflicts of interest

The authors declare no conflicts of interest.

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