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Physicochemical Characterization of Drinking Water Quality of the Communal Water Distribution Network in Souk Ahras City/ Algeria

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Abstract

Standards aim to limit the transmission of the infectious disease rough drinking water. To determine that the drinking water is safe and comply with the standards, information about the changes of the physicochemical parameters that occur during distribution was assessed in Souk Ahras city/Algeria. For this purpose, several samples from distribution network were taken at the consumer's tap during the spring and summer period of 2017/2018. The obtained values of each parameter of the 14 original physicochemical were compared with the standard values set by Algeria standards. The results showed that concentration levels of chlorine free, temperature, magnesium, turbidity, nitrate, phosphate, calcium exceeded the limits of Algeria standards in certain districts, while, pH, conductivity, sulfate, dissolved oxygen, permanganate index, ammonium and nitrite were well within the limits. Signs of the presence of harmful germs and probably malfunctions in part of the equipment of the treatment processing and distribution facilities were detected.

Keywords: Water Quality; Water Supply; Waterborne disease; Souk Ahras city; Algeria

Introduction

The parameters that control the evolution of the water quality in the network are complex and have been the subject of extensive research [1-7]. Quality is a universal health problem, it is essential for life, but it can transmit diseases in the countries of all continents from the poorest to the richest. The importance of quality in distribution is based on evidence regarding the frequency and extent of known quality changes and their impact on human health. A significant proportion of recognized diseases related to drinking water are related to deterioration in the quality during distribution [8,9]. Many people world wild rely on water supplied by tankers or other forms of vendor supplies [10]. The water in such supplies may come from hydrants connected to utility supplies or may be drawn from alternative sources. In many cases, the consumer will not be aware of the source of water and there may be significant concerns about the quality of water [11]. The pollution of water resources is an important challenge facing the developing countries, while pollution of water is attributed to high population growth.

Water can and does transmit disease, the most predominant waterborne disease and diarrhea has an estimated annual incidence of 4.6 billion episodes and causes 2.2 million deaths every year [12,13]. Consumption of water contaminated by disease causing agents (pathogens) or toxic chemicals can cause health problems such as Cholera, Typhoid, Dysentery, Cancer and Skin diseases [12,14]. In Algeria, water-borne diseases are well known, among these infections: Typhoid fever, Cholera, Infectious hepatitis, Dysentery, Poliomyelitis, etc. During 1986 [15], Algeria experienced the largest cholera outbreak in recent history. More than 475 deaths have been recorded. Tuberculosis occurs regularly but does not reach endemic levels. Every summer, public health authorities report limited occurrences of water-borne diseases, such as typhoid. HIV/AIDS is a concern in Algeria. In August 2018 the Ministry of Health announced a cholera outbreak in northern parts of the country in around Algiers province. A water source was found contaminated with Vibrio cholerae [16,17]. The goal of this paper is to characterize water supply quality of samples taken from different places in drinking water supply system in Souk Ahras city, which will be useful for decision makers to take proper initiative to prevent waterborne diseases and ovoid any possibility of harmful consequences on the public health.

Methods and Material

Study Area

The case study was carried out in Souk Ahras city; it lies in northeast of Algeria as shown the (Figure1). The area is supplied from distribution tanks located at the following 12 sites: SNIC, Clair Soleil, Faubourg, April 26, Rezgoun, University, Mezghich 1, Mezghich 2, Bendada 1, Bendada 2, Akli, Hospital. The volume produced is estimated at 35 000 m3/day defined as the average value for the year 2017 [15]. The distribution network covers a distance of 270 km. The network consists mainly of PVC with 69%, in the second position we find HDPE with 17%; concrete, Iron and cast iron in the third, fourth and fifth positions respectively. The pipes are from 63 to 160 mm in diameter as shown the (Figure 2). [18,19]. The system suffers from many problems, the most notable of which is the lack of continuous service. The causes of this situation are well known. They reside in the high rate of leaks due to the general poor condition of the network. In the network, some points offer an easy entrance of the microorganisms. This is the case of leaks in the distribution system as shown the (Figure 3), and where the poorly protected openings can allow the passage of dust or insects bringing contamination. Interventions on the network (repairs, connections) and accidents such as backflows or breaks can also be responsible for the introduction of microorganisms into the network.

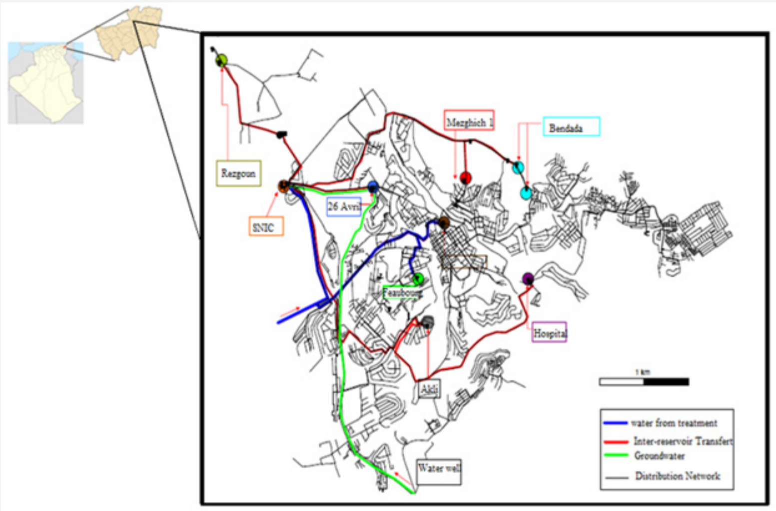

Figure 1: Sampling site from water supply system in Souk Ahras city.

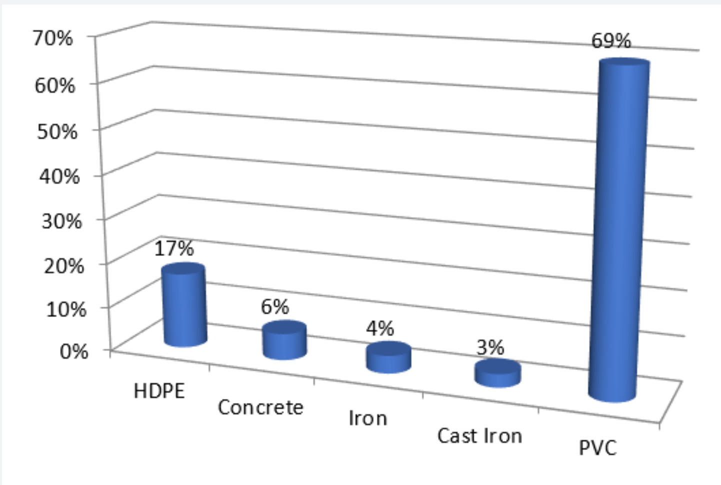

Figure 2: Type of pipes used in water supply.

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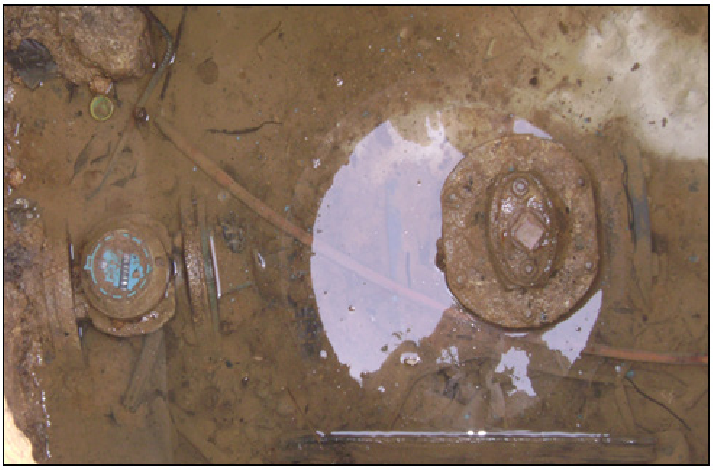

Figure 3: Leaks in water supply network.

Sample Collection

To confirm the monitoring task and restrict any probably anthropogenic effects, 201 samples of drinking water taken from the water supply network of the city for one year (2018) previously identified were measured in-situ and / or in the laboratory. The samples taken successively during the summer-autumn 2017 and winter-spring 2018 periods are analyzed by the water supply authority (ADE: Algerienne Des Eaux) laboratory of Souk Ahras city. Water taps situated mostly in private and commercial buildings were selected as sampling points, while sampling twice on each point during the study period. The collection and storage of water samples were carried out according to the Algerian standards.

Sample Analysis

The results of 14 parameters, including chemical and physical ones were determined in drinking water samples. To confirm the monitoring task and restrict any probably anthropogenic effects, 201 samples of drinking water taken from the water supply network of the city. Water samples analyzes were performed in accordance with methods standardized by the laboratories health agency and the Algerian authority for treatment and water supply (Algerienne Des Eaux: ADE) of Souk Ahras. The parameters measured are: pH (measured with pH Meter, type (WTW pH 330i/SET)), ammonium, nitrite, nitrate and sulfates (determined by a colorimetric method using a UV/visible spectrometer type (JASCO V-530)), turbidity (measured by Nephelometer using 0.02 NTU standards), temperature (measured on the site using mercury thermometer), conductivity (using pre-calibrated conductivity meter model 611), permanganate Index(ultraviolet-visible spectrophotometry), residual chlorine (visual spectrometry), phosphates (using colourimetric technique on photometer type palintest), dissolved O_2 (using an oximeter Type HACH), magnesium and calcium (were measured by EDTA-(Ethylenediaminetetraacetic-acid)- titration method).

Discussion

The analytical procedures followed throughout the analysis of 201 samples taken for the purpose of regular monitoring of the drinking water quality in the supply system of Souk Ahras town are characterized by 14 physicochemical variables as shown the (Table 1). The pH of drinking water has no immediate effects on human health but has some indirect health effects by bringing changes in other water quality parameters such as solubility of metals and survival of Pathogens [20]. According to Algerian standards [21] the pH of drinking water must be between 6.5 and 9, the results in (Table 1) show that the pH is between 6.00 and 8.4, therefore the water quality of Souk Ahras city is within the standards. The conductivity of the samples is very variable, the results show that the measured conductivity of all water samples ranges from 248 µS/cm to 1777 µS/cm, and the average conductivity value is 525,48 µS/cm (Table 1), which explain the variation of the water supply sources. According to Azrina et al. [22], the wide differences among the values of the conductivity of tap water are not yet known, in other hand Scatena [23] explained these differences based on various factors such as agricultural and industrial activities and land use, which affect the mineral contents and thus the conductivity of the water. The conductivity does not have direct impact on human health, it is determined for several purposes such as determination of mineralization rate (existence of minerals such as potassium, calcium, and sodium) and estimating the number of chemical reagents used to treat this water [3,14,24]. High conductivity may lead to lowering the aesthetic value of the water by giving mineral taste to the water. In all cases the conductivity values are within the acceptable limits. A significant part of the chlorine being necessary to neutralize the organic matter; a part called free residual chlorine remains in

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the water to treat possible subsequent contamination occurring within the distribution network and domestic plumbing system [2,7]. The concentration of free chlorine in treated water should be according to the Algerian standards: 0.2 - 0.5 mg/l. The maximum values recorded are located around the injection points - which are in general the distribution tanks such as: Ain Dalia Mixture Mris2, Mris3; in other hand, no concentration in free chlorine was recorded in several points at the ends of the network. The average value of the free chlorine is acceptable and within the Algerian standards: (Max: 1,20mg/l, mean: 0.16 mg/l).

Table 1: Summary statistics for drinking water samples.

	Nbr Valid	Nbr Missing	Mean	Median	Std. Deviation	Min	Max	Standard
PH	201	3	7,56	7,59	0,36	6,00	8,40	6,5 - 9
COND (µs/ cm)	201	3	525,48	487,00	167,91	248	1777,00	2800,00
Cl_2 (mg/l)	200	4	0,16	0,10	0,19	0,00	1,20	0,2 - 0,5
T(C°)	201	3	14,59	14,00	4,56	6,00	29,00	25,00
O_2 (mg/l)	201	3	0,16	0,15	0,04	0,05	0,29	5,00
Mg (mg/l)	201	3	41,89	43,00	10,82	17,49	68,00	50,00
SO_4^{2-} (mg/l)	194	10	160,44	159,50	74,39	27,74	386,71	400,00
Turb (NTU)	201	3	2,08	1,34	1,99	0,33	12,00	5,00
IP (mg/l)	201	3	1,29	0,96	0,89	0,30	4,80	5,00
NO_{3^-} (mg/l)	201	3	0,55	0,00	4,70	0,00	52,00	50,00
NH_4 (mg/l)	201	3	0,02	0,00	0,08	0,00	0,47	0,50
NO_{2^-} (mg/l)	198	6	0,01	0,00	0,03	0,00	0,12	0,20
PO_4 (mg/l)	201	3	0,01	0,00	0,07	0,00	0,48	0,40
Ca (mg/l)	199	5	99,72	87,00	33,16	72,00	200,00	200,00

A high temperature can favor unpleasant tastes. In addition, it accelerates corrosion and influences bacterial growth; on the other hand, any reduction in the dissolved oxygen content can be interpreted as a sign of biological growth. The temperature fluctuates on average from 6°C to 29°C (mean: 14.59 °C), the small increase in temperature was recorded in the summer period which is not far from the Algerian standards: 25°C; for the dissolved oxygen the results are not in compliance with Algerian standards: (5mg/l), the concentration in some tanks is ranged from 0.05mg/l to 0.29mg/l, which require a bacteriological analysis of all water tanks. Several epidemiological studies have reported significant inverse associations between drinking water magnesium concentrations and mortality from ischaemic heart disease [25,26], but others have not [27]. The magnesium levels in the water is extremely varied and related mainly to the nature of the geological layers of Souk Ahras region. The excess in magnesium gives a bitter taste to the water. In regions rich in magnesium rocks, water can contain concentrations up to 50 mg/l. For Souk Ahras city the average is: 41.89 mg/l which is lower than the Algerian standards: 50mg/l, on the other hand several samples were recorded a high concentration, especially for: Arrival Ain Dalia, Cite 1700 logts, Mezghiche reservoir, Rhamna subdivision N° 04 and Snic tank. Sulfate is also belonging to the standards limits. The sulfate dissolves in water comes from certain minerals, in particular gypsum, where it appears from the oxidation of sulfurous minerals. No major negative impact of sulfate on human health is reported [28]. The maximum recorded is around 386.71 mg/l; although the upper limit is close to the authorized limit, but it remains acceptable. Turbidity is an indicator parameter for microbiological contamination of the resource and can testify to malfunction in the processing and distribution facilities reflecting the cloudy water due to suspended solids. The waters of Souk Ahras can be classified as slightly cloudy (Max= 12 NTU, mean: 2,08 NTU), more attention should be paid to this parameter to avoid the harmful consequences of the amount is increased. The presence of organic matter in water causes the existence and proliferation of microorganisms which can be pathogenic. Therefore, the determination of the content of these organic matters is essential in monitoring of the water quality. All permanganate index results are within the standards, where they ranged from 0.3 mg/l to 4.8 mg/l, with an average value of 1.29 mg/l.

Nitrate pollution is associated with leaching from industrial and sewage effluents, fertilizers and treated distillery effluent for crop irrigation are main responsible sources [29]. Its excessive presence can cause a major public health problem such as methemoglobinemia [30]; a slight overshoot is recorded for the Amirat Sliman district with a concentration of 52 mg/l. The mean: 0,55 mg/l is within the permissible limits of the Algerian standards,

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For the nitrite, the (Table 1) shows that the concentration belongs to the standard limits with less than 0.2mg/l. The presence of ammonium in relatively high concentration in drinking water is associated with many potential hazards. The ammonium stimulates the growth of undesirable bacteria, like autotrophs [31]. Excessive ammonium in drinking water may lead to bacterial contamination of the water distribution system [32]; this is related to health risk associated particularly with microbiological content of faecal material. The value recorded for the Souk Ahras city was 0.47mg/l, which is within the permissible limits of 0.5mg/l. Phosphates are not toxic to people or animals unless they are present in very high levels [29]. Digestive problems could occur from extremely high levels of phosphate. The natural phosphate or orthophosphate concentration is in the range of 0.1 to 0.4 mg/l. Phosphates are generally responsible for the acceleration of the eutrophication phenomenon. For all the samples the maximum value recorded exceeds hardly the standards where this was recorded for a single point in the Akli Reservoir, which may reflect lack of hygiene (Max: 0.48 mg/l, mean: 0.014 mg/l). A good quality of drinking water has a limit of 200 mg/l of calcium. About 95% calcium in human body stored in bones and teeth. The high deficiency of calcium in humans may cause rickets, poor blood clotting, bones fracture etc; and the exceeding limit of calcium produced cardiovascular diseases [28]. The domestic disadvantage associated with high concentration is calcium build-up in the pipes; on the other hand, fresh water can cause problems of corrosion of the pipes. The distributed water in Souk Ahras city is adequately complies with the Algerian standards (Max: 200mg/l, mean: 99,72mg/l).

Conclusion

Based on the results discussed above the values of water quality parameters such as pH, Conductivity, Sulfate, dissolved oxygen, permanganate index, ammonium and nitrite were well within the limits of Algerian standards; while concentration levels of Chlorine free, Temperature, Magnesium, Turbidity, Nitrate, Phosphate, Calcium exceeded the limits in certain districts. The presence of the Ammonium and the low concentration of the residual Chlorine combine with the state of the network can be considered as signs of the presence of harmful germs and probably malfunctions in part of the equipment of the treatment processing and distribution facilities. A rough and continuous check is more than necessary to preserve public health.

References

1. Powell JC, Clement J, Brandt M (2004) Predictive models for water quality in distribution systems. London, UK. IWA publishing, Alliance House. pp: 106.
2. World Health Organization (2004) Guidelines for drinking-water quality. Recommendations, 3rd Edition. Volume 1, Geneva.
3. Speight V, Uber J, Grayman W, Martel K, Friedman M, et al. (2009) Probabilistic modeling framework for assessing water quality sampling programs. Denver, Colorado, USA. Water Research Foundation.
4. Nilufar I, Rehan S, Manuel JR, Christelle L (2016) Assessment of water quality in distribution networks through the lens of disinfection by-product rules. Water SA 4(2): 337-349.
5. Guebail A, Bouzian MT, Zeghadnia L, Djebbar Y, Bouranene S (2017) Rainwater harvesting in Algeria: utilization and assessment of the physicochemical quality: Case study of Souk-Ahras region. Revue de Courrier de savoir 23: 85-94.
6. Nilufar I, Manuel JR, Farahat A, Rehan S (2017) Minimizing the impacts of contaminant intrusion in small water distribution networks through booster chlorination optimization. Stochastic Environmental Research and Risk Assessment 31(7): 1759-1775.
7. Bensoltane MA, Zeghadnia L, Djemili L, Gheid A, Djebbar Y (2018) Enhancement of the free residual chlorine concentration at the ends of the water supply network: Case study of Souk Ahras city-Algeria. Journal of Water and Land Development 38(VII-IX): 3-9.
8. Craun GF, Calderon RL (2001) Water disease outbreaks caused by distribution system deficiencies. Journal of American water works association 93: 64-75.
9. Ainsworth RA (2002) Water quality changes in piped distribution systems. World health organization.
10. Whittington D, Lauria DT, Mu S (1991) A study of water vending and willingness to pay for water Onitsha, Nigeria, World Devolpment 19(2/3): 179-198.
11. Loyd B, Helmer R (1991) Surveillance of Drinking Water Quality in Rural Areas. Longman, Harlow, UK.
12. (2005) World Health Organization Nutrients in Drinking Water WHO Library Cataloguing-in-Publication Data, ISBN 92 4 159398 9. Switzerland.
13. Ikelionwu C (2012) Water quality monitoring and surveillance in Nigeria. Dept. Of water supply and quality control, Federal Ministry of water resources, Abuja, Paper presented at the projects/ programs of FMWR on water quality.
14. Awopetu MS, Coker AO, Aribisala JO, Awopetu SO (2013) Water quality in a pipe distribution network: A case study of a communal water distribution network in Ibadan, Nigeria. Water Resources Management pp: 175-186.
15. Bensoltane MA, Zeghadnia L, Guebail A, Araibia AS, Djemili L (2019) Assessment of the bacterial pollution in the distribution network/ case study of Souk Ahras town, Algeria. 2nd Euro-Mediterranean conference for environment integration, Sousse/Tunisia pp: 2331-2335.
16. (2018) Ministry of Population Health and Hospital Reform. Epidemiological situation of cholera cases. Algiers: Ministry of Health, Population and Hospital Reform.
17. Bensoltane MA, Zeghadnia L, Guebail A, Araibia AS, Djemili L, et al. (2020b) Control of the water supply quality: case study of Souk ahras city/Algeria. Euro-Mediterranean Journal for Environmental Integration 60(1): 1-9.
18. Bensoltane MA (2020a) Degradation of the quality of drinking water in the distribution networks / case of the city of Souk Ahras. PhD Thesis, Badji Mokhtar Annaba University.
19. Zeghadnia L (2007) Computation of the pressurized turbulent flow in circular pipe. Magister Thesis, Badji Mokhtar University, Algeria.
20. Zabed H, Suely A, Faruq G, Sahu JN (2014) Water quality assessment of an unusual ritual well in Bangladesh and impact of mass bathing on this quality. Science of the Total Environment 472: 363-369.
21. Official Journal of the Democratic and Popular Algerian Republic JORA (2011) Executive decree N°11-125 of 17 Rabie Ethani 1432 corresponding to 22 March 2011defining the humane drinking water quality, Journal N°18.

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22. Azrina A, Khoo HE, Idris MA, Amin I, Razman MR (2011) Major inorganic elements in tap water samples in Peninsular Malaysia. Malaysian Journal of Nutrition 17(2): 271-276.

23. Scatena FN (2000) Drinking water quality: In Drinking Water from Forests and Grasslands: A Synthesis of the Scientific Literature, G. E. Dissmeyer, Edition, General Technical Report SRS-39 Department of Agriculture, Southern Research Station, Asheville, NC, USA, pp: 246.

24. Rahmanian N, Siti Hajar BA, Homayoonfard M, Ali NJ, Rehan M, et al. (2015) Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia. Journal of Chemistry p: 1-11.

25. Punsar S, Karvonen MJ (1979) Drinking water quality and sudden death: observations from West and East Finland. Cardiology. 64(1): 24-34.

26. Rubenowitz E, Axelsson G, Rylander R (1996) Magnesium in drinking water and death from acute myocardial infarction. American Journal of Epidemiol 143(5): 456-62.

27. Maheswaran R, Morris S, Falconer S, Grossinho A, Perry I, et al. (1999) Magnesium in drinking water supplies and mortality from acute myocardial infarction in Northwest England. Heart 82(4): 455-460.

28. Fadaei A, Sadeghi M (2014) Evaluation and Assessment of Drinking Water Quality in Shahrekord, Iran. Resources and Environment 4(3): 168-172.

29. Singh B, Chauhan JS, Mohan A (2012) A construction of water quality index considering physicochemical properties for drinking purposes in a rural settlement: a case study of Gajraula region, Ganga River Basin (North India). Water Science Technology Water Supply 12(6): 818-828.

30. Guergazi S, Achour S (2005) Physico-chemical characteristics of the supply water of the city of Biskra. practice of chlorination, Larhyss Review 4: 119-127.

31. Qin W, Li W, Zhang D (2016) Ammonium removal of drinking water at low temperature by activated carbon filter biologically enhanced with heterotrophic nitrifying bacteria. Environment Science Pollution Research 23(5): 4650-4659.

32. Van DKD, Hijnen W, Kruithof JC (1989) The effects of ozonation, biological filtration and distribution on the concentration of easily assimilable organic-carbon (AOC) in drinking-water. Ozone: Science & Engineering 11: 297-311.

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