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Monitoring the Quality of Tap Water in some Distribution Networks in Damietta Governorate

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Abstract

The quality of drinking water is an important indicator of human health. Therefore, a study was conducted to evaluate the physico-chemical and biological quality of tap water at various network points in the Damietta governorate, where the water is distributed to consumers. Nine samples of three distribution networks for three treatment plants located on the Nile were collected seasonally during the year 2022 and subjected to analysis for different physico-chemical and biological characteristics, in addition to some heavy metals. Metrics of heavy metal pollution (PI) and water quality (WQI) were applied to evaluate the water status. Moreover, a one-way ANOVA was implemented to compare the temporal and spatial variation of WQI. The result showed that the mean values of turbidity, electrical conductivity, pH, total dissolved solids, and total hardness of tap water were 0.2±0.6 NTU, 296.2±19.8 µmohs/cm, 7.2±0.14, 183.3±4.3, and 528±212 mg/l, respectively. In addition, ammonia, residual chlorine, chlorides, sulphates, calcium, magnesium, iron, lead, cadmium, and zinc concentrations were 0.014±0.01, 0.5±0.5,35.3±6.3, 34.1±5.7,63.4±17,23.2±4.8, 0.02±0.01, 0.01±0.01, 0.003±0.005, and 0.07±0.03 mg/l, respectively. The total plate count was 23.4±8.1 CFU/100 ml. The obtained results revealed that all the measured parameters were within permissible limits, according to WHO (2017). The Average Water Quality Index (AWQI) values (56.6, 56.58, and 52.9, respectively) of distribution networks 1, 2, and 3 confirmed that the tap water in the study area was of good quality. This study recommends the continuous upkeep of water pipes throughout distribution networks to avoid water contamination and ensure compliance with international standards.

Keywords: Drinking Water Quality; Distribution Networks; Physicochemical Parameters; Heavy Metals; Water Quality Index.

Introduction

A basic and crucial human right is an abundance of safe water for drink. Clean water supply is essential for economic growth, environmental preservation, lifestyle enhancement, and community health. Waterborne diseases can develop and spread as a result of both quantitative and qualitative lack of access to safe drinking water **(Kumpel *et al.*, 2018;** Roeger and Tavares, 2018; Afifi *et al.*, 2023). Globally, 6.3% of deaths and 9.1% of diseases can be prevented by improving health through access to safe potable water (Bazgir et al., 2020).

Safe water monitoring and maintenance of the world's drainage and water supply systems is difficult, though It is estimated that diseases spurred up by contaminated water kill 502,000 people annually (El-Emam, 2020). The World Health Organization (WHO) reported in 2017 that while two billion people have been granted access to drinking water since 1990, 780 million people globally have limited access (Kirk *et al*., 2017). Every society's capacity for sustainable development and overall well-being depends on its availability of clean, abundant water (Eslami *et al*., 2018).

Drinking water distribution systems employ a variety of barriers from catchments to consumers in an effort to eliminate, minimize, and avoid microbiological and other contaminants in water. It is precisely the responsibility of water distribution network management to maintain the treated water quality until it reaches customers through distribution systems and inhibit the access of pathogens (Yang et al., 2011; Kouassi et al., 2023). Water distribution networks are a component of water systems that convey cleaned water from water treatment facilities to the taps of consumers. These networks may be susceptible to contamination from outside resources, such as sewage or soil water which lead to lose their hydraulic or physical integrity (Besner *et al*., 2011; Meran *et al*., 2021).

To provide clean water to the final customer, water piping network systems be should be continuously maintained. Processing and storage at treatment facilities as well as distribution networks result in a decrease of drinking water quality (Akoto *et al*., 2017; Karen *et al*., 2021). Most sources of water lose quality when they enter the residence's plumbing system because of contaminants or microorganisms, which may be present due to pipe malfunctions, joint leaks, or the growth of bacteria on pipe wall. Therefore, it's important to evaluate the water quality not only in the treatment facilities but also in water distribution system to provide high drinking water quality (Karen *et al*., 2021).

Primitive societies are more probable to evolve close to water sources. Pipes were first used by humans for transferring water around 3500 years ago (Martinez et al., 1999). Thus, it is anticipated that early civilizations developed around basins of rivers, such as, Nile River in Egypt, India's Indus, China's Hwangho, and Euphrates and Tigris in Iraq (Arunkumar and Mariappan, 2011). Primitive man digging canals to convey water over long distances for daily uses. The most important conditions for excellent health are fresh water accessibility, affordability, safety, and consistency. Water is an essential resource for economic activity, ecological processes, and human life and culture. Due to overpopulation and climate change, there has been a surge in demand for water supply, and many areas are experiencing a regression in water management, as stated in various international declarations. (Hossain, *et al*., 2021; Elemam and Eldeeb, 2023).

Contamination of originally safe drinking water through transport, and storage has been related to spread of shigellosis, hepatitis E, and cholera in internally displaced populations (IDP) and refugee in South Sudan, Malawi, Kenya, Uganda, and Sudan (Golicha *et al*., 2018; De Santi *et al*., 2022). Global drinking water quality guidelines (GDWQG) recommend 0.2 mg/L at least of free residual chlorine (FRC) to be provided throughout the post-distribution period to prevent recontamination by priority pathogens (De Santi *et al*., 2022).

Monitoring water quality and managing water resources are considered national priorities for sustainable development. Monitoring programs are necessary to evaluate the quality of the water through the assessment of physicochemical parameters, which provide a vast data matrix that is frequently used to calculate the water quality index (García-Avila et al. 2022). When selecting the proper treatment method for such problems, the Water Quality Index (WQI) is a useful and distinctive rating that can represent the total state of the water in a single term. Reviewing the WQI standards for the suitability of sources of drinking water has been attempted. Though it varies greatly depending on the type of pollution-causing activities in the catchment area, organic pollution at one location, nutrient contamination at another, and/or heavy metal contamination. Thus the degradation of water quality is not consistent across all water bodies (Manna and Biswas, 2023).

Most researches related to monitoring water quality has been limited to evaluate the quality of water source, but few of them have focused on monitoring and evaluating the quality of tap water. Thus the aim of this study is to assess tap water quality in the distribution rural networks for some distribution points at Damietta governorate and the following objectives were implemented to achieve this aim: 1) determination of some physicochemical and biological parameters and compare with standard criteria for drinking water. 2) Employ water quality and pollution indices in addition to some statistical analysis to identify and confirm the class of water quality for the investigated water samples.

Material and Methods

Study Area

Nine water samples were collected seasonally from 9 points of distribution networks of three conventional drinking water treatment plants for a yearlong period (Winter, Spring, Summer and Autumn 2022) (Figure 1). Water samples were collected in high density polyethylene bottles, which were previously acid-treated with 0.5 N HCl, rinsed with deionized water, dried, and stored in clean environment to avoid contamination. Before filling the bottle samples, the tap was left running for about fifteen minutes. The water flow was then reduced to allow for splash-free bottle filling. For microbiological investigation and prior sterilization, the bottles' gasses were first released by filling them to capacity, emptying them over tap water, and then refilling them in the same way. Furthermore, samples for chemical analysis were promptly filtered through a Millex® Millipore (0.45) µm filter. Three water samples were collected from each sampling point for each station as following: (i) the first bottle was filled with unfiltered non acidified water for microbial analysis and stored in ice box (4°C) then kept in dark to be analyzed within 24 hrs from the collection time. (ii) the second bottle was filled with non-acidified water for analysis all parameters except heavy metals, (iii) the third bottle was filled with filtered and acidified water (by adding one drop of 70% HNO_3,) for multi-elements analysis. After arrival to the laboratory all the collected water samples were immediately analyzed as soon as possible.

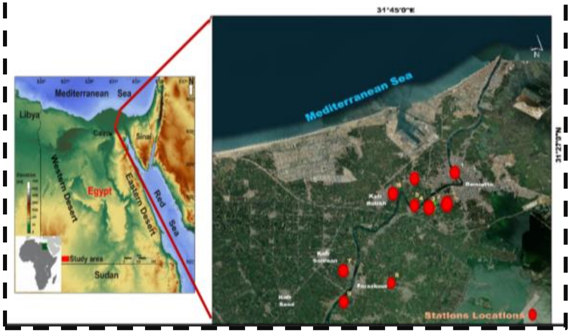

Figure (1): Distribution network sites along the study area

Analysis of Physicochemical and Biological Parameter

Physicochemical analysis

water parameters were measured on-site using portable multi-probe water quality analyzers that were calibrated before utilization, including temperature, turbidity, pH, EC, and TDS. The only preservation techniques used were freezing, refrigeration, chemical addition, and pH control.

According to the electrometric method described by APHA (2017), the pH value of the samples was measured directly using a pH meter (model 211 HANNA; USA). On the other hand, the turbidity of the samples was measured Nephelometric according to Method, by Al 1000 Turbidimeter (a German aqualytic device with a measurement range of 0-200 NTU). The digital meter (Digital Portable TDS/ Conductivity meter Model, 8033 HANNA; USA) was used to measure the TDS (mg/l) and EC (µmohs/cm). Furthermore, the standard procedures for the examination of water and waste water were followed in the analysis of chlorides, alkalinity, residual chlorine, total, calcium, magnesium hardness, and macronutrients such as ammonia and sulfate (APHA, 2017). Using the Perkin Elmer Optima 3000, USA, inductively coupled plasma-mass spectrometry 7000, the heavy metals (lead, zinc, iron, and cadmium) were measured. The manufacturer's instructions were followed for pre-measuring instrument calibration. The acquired results were verified using sample triplication and standardization.

Bacteriological analysis

In accordance with the Standard Procedures for

Examination of Water and Wastewater (APHA, 2017), all samples were evaluated within six hours after collection. The total plate count (TPC) was recorded using the pour plate method. The petri dishes were filled with nutrient agar medium, and left to be rigid, then inverted and incubated at 37°C for twenty-four hours against negative control plates.Finally, each dish was count by a colony counter (Cook Electoromics LTD) and the colony forming unit (CFU/100ml) was reported.

Water Quality Index

In order to evaluate the quality of drinking water, various WQI models have been developed and used globally in recent years. These models were computed using the specified weighted arithmetic index approach. The suitability of the sixteen major physiochemical parameters (pH, temperature, EC, TDS, alkalinity, total hardness, calcium hardness, magnesium hardness, calcium, magnesium, chloride, sulfate, ammonia, residual chlorine and total plate count) for human consumption was assessed.

WQI was determined using the formula created by **Tiwari and Manzoor (1988)**. The following expression yields the quality rating (qi) for the water quality parameter:

$$qi = 100\ \mathrm{Vi/Si} \qquad (1)$$

Where Vi is the noticed value of the parameter at a specified sampling site, and Si is the standard water quality. Equation (1) clarified that qi = 100 if the observed value is just equal to its standard value. Thus, the larger value of qi indicated polluted water.

To calculate WQI, the quality rating qi according to the parameter can be measured by the next equation:

The overall WQI was:

$$\mathrm{WQI} = \sum \mathrm{qi} \qquad (2)$$

The average water quality index (AWQI) for n parameters which was computed using the following relation:

$$\mathrm{AWQI} = \sum \mathrm{qi} / \mathrm{n} \qquad (3)$$

AWQI was classified into 5 categories: excellent (< 50), good (50.0 – 100), poor (100 – 200), very poor (200 – 300) and unsuitable (over 300) as displayed in Table (1)

Table (1): Water quality categorization according to WQI value

Water Quality Index Level	Water Quality Status
<50	Excellent
50-100	Good
100-200	Poor
200-300	Very poor
>300	Unsuitable

Metal Pollution index

The pollution index (PI), which is based on individual metal calculations was utilized to assess the level of heavy metal contamination in water samples and classified into five classes (Table 1) based on equation (4). The acceptable level is the element concentration in the water deemed safe for human consumption.

$$PI = \sum_{i=0}^{n} \frac{Ci}{Si} / \mathrm{Nm} \quad \mathrm{i=1} \qquad (4)$$

Where Ci = Heavy metal concentration in water; Si= permissible Level and Nm = Number of Heavy metals. Water sample with Pollution Index (PI) <1 is recognized as benign (has no effect); (PI) = 1-2 (Slightly affected); (PI) = 2-3 (Moderately affected); (PI) = 3-5 (Strongly affected); (PI) = 4-5 (Seriously affected).

Statistical Analysis

Descriptive statistics were calculated for the recorded parameters of the examined water samples. The correlation between each pair of parameters was determined using the Pearson correlation coefficient. WQI was indicated using programmed application utilizing Microsoft excels sheet programs, and the temporal and spatial fluctuation of WQI values was compared using One-way ANOVA. This carried out using SSPS 26.

Results

Physicochemical parameters and heavy metals

Physical and chemical parameters for the addressed tap water samples were displayed in Table (2). The results revealed that the average value of temperature of distribution networks (tap water) was 10.3 ±1.17 ºC with maximum value 13 ºC at point 8 in summer, and minimum value 8.5 ºC at point 5 in autumn.

The value of pH was 7.2 ±0.14 with the highest value 7.38 at point 1 in spring and the lowest value was 6.8 at point 5 in winter.

The turbidity of the investigated water samples ranged from 0 to 2.07 NTU with an average 0.21 ±0.59 NTU.

Table (2): Physicochemical characterization of distribution networks (tap water) in the study area.

parameters	**distribution networks**					**Standard limits (WHO, 2017)**
	unit	Min	Max	Mean	Standard deviation	
Turbidity	(N.T.U)	0	2.07	0.2	0.6	5
pH	-	6.8	7.3	7.2	0.14	6.5-8.5
Temperature	°C	8.5	13	10.3	1.17	≥ 15
TDS	mg/l	174	192	183.3	4.29	500
EC	µmohs/cm	273	350	296.2	17.8	1600
Chlorides	mg/l	23.4	45	35.3	6.3	250
Alkalinity	mg/l	11	27.2	19.5	3.8	<200
Total Hardness	mg/l	299	910	528.3	212	500
Calcium Hardness	mg/l	194	470	290.7	93.5	350
Magnesium Hardness	mg/l	70	488	237.7	131	150
Calcium	mg/l	34.2	88	63.4	17	75
Magnesium	mg/l	13.5	30.7	23.2	4.8	50
Ammonia	mg/l	UDL	0.03	0.0	0.01	1.5
Sulphate	mg/l	22	46	34.1	5.7	250
R.CL	mg/l	0.1	1.6	0.5	0.5	0.2-0.5
Total plate count	100/ml	11	40	23.4	8.1	<50
Iron	mg/l	0	0.06	0.02	0.01	0.3
Lead	mg/l	0.003	0.03	0.01	0.01	0.01
Cadmium	mg/l	0.001	0.03	0.003	0.005	0.003
Zinc	mg/l	0.003	0.13	0.07	0.03	3

The obtained TDS values fluctuated between 177 mg/l at point 6 in winter and 190 mg/l at point 8 in winter with an annual average of 183.9 ±3.1 mg/l.

The annual mean values of EC varied between 273 µmohs/cm at point 4 in summer and 350 mg/l at point 4 in winter with an average 296.2 ±17.8 µmohs/cm.

It was noticed that the chloride average was (35.3 ± 6.3 mg/l). The mean values varied between 23.4 mg/l at point 5 in winter and 45 mg/l at point 8 in in autumn.

The alkalinity average of distribution networks was 19.5 ± 3.8 mg/l, while annual mean values varied between 11 mg/l at point 4 in summer and 27.2 mg/l at point 7 in in winter.

In current study the highest concentration of total hardness was 910 mg/l at point 9 in spring, while the lowest value was 299 mg/l at point 2 in winter with an average (528 ± 212 mg/l).

The average concentration of calcium hardness in the addressed water samples during the study period was 290.7 ± 93.5 mg/l with peak value of 470 mg/l at point 7 in winter, while the lowest value (194 mg/l) was observed at point 9 in spring. The annual mean values of magnesium hardness varied between 70 mg/l at point 4 in spring and 488 mg/l at point 2 in summer with an average 238± 131 mg/l.

The average value of calcium in the examined tap water was 63± 17 mg/l, while annual mean values ranged between 34.2 mg/l at point 6 in winter and 88 mg/l at point 1 in autumn.

The highest concentration of Magnesium was 30.7 mg/l at point 2 in autumn, while the lowest was 13.5 mg/l at point 4 in winter with the average of 23.2± 4.8 mg/l during study period.

The value of ammonia was 0.014± 0.01 mg/l (most of points had non detected ammonia in different seasons), however there was maximum value at point 7 in winter (0.03 mg/l).

sulfate concentrations varied between 22 mg/l at point 1 in spring and 46 mg/l at point 6 in autumn with an annual average 34.1± 5.7 mg/l.

The Residual chlorine (R.Cl) values varied from 0.1 mg/l at point 4 and point 7 in winter to 1.6 mg/l at point 5 in spring with mean value 0.5± 0.5 mg/l.

It was found that value of iron concentration was 0.019± 0.01 mg/l. Annual mean values varied between non detected (ND) at point 7 in spring and 0.06 mg/l at point 9 in winter.

Lead concentrations in the collected tap water was 0.011± 0.01 mg/l, while the minimum value was 0.003 mg/l at point 9 in autumn and the highest concentration was 0.032 mg/l at point 7 in winter. cadmium average was (0.003± 0.005 mg/l). The mean value of zinc was (0.07± 0.03 mg/l).

The average value of total plate count (TPC) of distribution networks during the study period was 23.4± 8.1 (CFUs/100ml), while annual mean values varied between (11 CFUs/100ml) at point 8 in winter and (40 CFUs/100ml) at point 5 in autumn.

Estimation of water quality index

The weighted arithmetic approach of WQI was used to assess the water quality of tap water for the targeted distribution networks of each station in accordance with drinking standards. The values of WQI of tap water, as indicated in Table (3), showed that the estimated WQI values of distribution network (DNW) 1, 2 and 3 were 56.6, 56.58 and 52.9, respectively.

Table (3): WQI and AWQI of Distribution network (DNW) 1, 2 and 3.

parameters	**DNW 1**		**quality Status**	**DNW 2**		**quality Status**	**DNW 3**		**quality Status**
	average	qi		average	qi		average	Qi	
Turbidity	0.6	12	Excellent	0.03	0.65	Excellent	0.02	0.4	Excellent
PH	7.2	85	Good	7.2	84.8	Good	7.3	85.7	Good
Temperature	C°	65	Good	10.0	66.8	Good	11.0	73.6	Good
TDS	9.8	36	Excellent	185.6	37.1	Excellent	183.5	36.7	Excellent
EC	180.8	19	Excellent	296.7	18.5	Excellent	295.3	18.5	Excellent
Chlorides	296.6	15	Excellent	33.7	13.5	Excellent	35.5	14.2	Excellent
Alkalinity	36.6	10	Excellent	19.0	9.5	Excellent	20.4	10.2	Excellent
Total Hardness	19.06	111	Poor	543.8	108.8	Poor	487.1	97.4	Poor
Calcium Hardness	554.1	86	Good	292.7	83.6	Good	277.2	79.2	Good
Magnesium Hardness	302.2	168	Poor	251.2	167.4	Poor	209.9	139.9	Poor
Calcium	251.9	87	Good	63.6	84.8	Good	61.5	82.0	Good
Magnesium	65.1	48	Excellent	21.5	42.9	Excellent	24.0	48.0	Excellent
Ammonia	24.1	1	Excellent	0.01	0.8	Excellent	0.017	1.1	Excellent
Sulfate	0.01	13	Excellent	35.1	14.0	Excellent	33.8	13.5	Excellent
Residual chlorine	33.3	108	Good	0.6	121.7	Good	0.5	96.7	Good
Total plate count	0.5	41	Excellent	25.2	50.3	Excellent	24.4	48.8	Excellent
WQI = Σ qi i=1	905			905.3			846		
AWQI = Σ qi/n	56.6		Good	56.58		Good	52.9		Good

Pollution index (PI)

The current investigation expanded in order to measure the extent of heavy metal-induced water pollution, particularly that resulting from iron (Fe^{+2}), lead (Pb^{+2}), cadmium (Cd^{+2}), and zinc (Zn^{+2}) which were assessed by the Pollution index (PI). The findings presented in Table (4) demonstrate that pollution index value of distribution network (DNW) 1, 2 and 3 were 0.6, 0.4 and 0.44, respectively.

Table (4): PI for heavy metals of distribution network 1, 2 and 3.

Parameters	**Average**			**(Ci/Si)/ Nm**		
	DNW 1	**DNW 2**	**DNW 3**	**DNW 1**	**DNW 2**	**DNW 3**
Iron	0.02	0.02	0.02	0.015	0.015	0.016
Lead	0.01	0.01	0.01	0.25	0.25	0.25
Cadmium	0.004	0.002	0.002	0.33	0.17	0.17
Zinc	0.07	0.06	0.08	0.006	0.005	0.007
PI=∑(Ci/Si)/Nm				0.6	0.4	0.44

Discussion

Physicochemical parameters and heavy metals

The primary indicator of water's acidity and alkalinity that can be depended upon is pH **(Dutt and Sharma, 2022)**. It indirectly affects the water's quality and acceptability for drinking **(Banna et al., 2014)**. In addition, it is a crucial water quality parameter, according to international publications released by the WHO, EUs, and EGs, it has no direct effect on consumers.

The value of turbidity was 0.21 ±0.59 NTU and it falls within the permissible limit according to WHO standards. This result was lower than that obtained (0.87± 0.52, 0.55± 0.35 NTU and 2.8 to 16.8 NTU) by **(**Sakran *et al*., (2019); Mahmoud *et al*., (2018) and Abou-Dobara *et al*., 2023). As turbidity reduces, light is reflected and adsorbed, increasing the water's clarity to transmitted light. This serves as an obvious indicator of good water quality (Smysem *et al*., 2020).

It was found that the average value of TDS (183.9 ±3.1 mg/l) was lower than that reported (308 ±56 mg/l) by (Sakran *et al*., 2019) and higher than that obtained (68.02± 6.86 mg/l) by (Mahmoud *et al*., 2018). In this study TDS values range (from 177 to 190 mg/l) was lower than the range detected (from 206 mg/l to 293.76 mg/l) by (Abou-Dobara *et al*., 2023). low TDS values may also be associated with the increased rate of water drainage from precipitation besides the slow rate of water evaporation (Smysem *et al*., 2020).

It was noticed that the annual average of electrical conductivity (EC) (296.2 ±17.8 µmohs/cm) was lower than that documented (552 ±101 µmohs/cm) by (Sakran *et al*., 2019) and higher than that obtained (135.03± 13.87 mg/l) by (Mahmoud *et al*., 2018). This may be owing to the existence of inorganic dissolved solids, which are sensitive to fluctuations in total dissolved solids. This variation can be associated with the reduction in water level and volume (Adjovu *et al*., 2023).

The chloride average of tap water in the study area (35.3 ± 6.3 mg/l) was lower than that reported (49.2 ±15.3 mg/l and 70.6 to 17.2 mg/l) by (Sakran *et al*., 2019 and Abou-Dobara *et al*., 2023), respectively and higher than that recorded (12.9 ±2.43 mg/l) by (Mahmoud *et al*., 2018). The values of chloride ions in water may be attributed to anthropogenic activities and leaching of saline residue (Sener *et al*., 2017).

Although alkalinity is a characteristic of water that depends on the existence of certain chemicals like bicarbonates, carbonates, and hydroxides, it is not a chemical description of water (Badr *et al*., 2013).The result value of alkalinity was lower than that reported (129 ±6.9 mg/l) by Sakran *et al*., (2019). In general, decrease in alkalinity result in increase of water corrosivity because alkalinity is essential for the reaction of alum with water in the coagulation process of the treatment plant (García-Ávila *et al*., 2022).

In the current study, total hardness concentration (528 ± 212 mg/l) was higher than that documented (163.9 ±18.6 mg/l) by (Sakran *et al*., 2019) and lower than that detected (133-200) by (Abou-Dobara *et al*., 2023). High values of total hardness influence the distribution network's susceptibility to corrosion (García-Ávila et al., 2022). Hard water isn't harmful to health, but it's not always suitable for washing, drying, and bathing. On the positive side, its lower value is perfect to avoid pipe corrosion (Dandge, 2022).

The average value of calcium (63± 17 mg/l) in the examined tap waters was higher than that obtained (24.29 ± 0.99 mg/l) by (Mahmoud *et al*., 2018). The existence of calcium made it easier for a protective coating to form on the pipe's surface, which reduced corrosion (Brossia, 2018).

The magnesium average 23.2± 4.8 mg/l during the study period was higher than that determined (1.09± 0.19 mg/l) by (Mahmoud *et al*., 2018). The changes of Mg values may be due to climate fluctuations, particularly the obvious increase in temperatures which lead to increase the evaporation rates. These variations may also be related to the applied treatment methods which include the addition of specific chemicals at particular stage (Brossia, 2018; Alver, 2019).

According to world health organization (WHO) and drinking water standards, consumer's tap water must be free from ammonia. In this study most of points of distribution networks had non detected ammonia in different seasons; however there was maximum value at point 7 in winter (0.03 mg/l). This low amount may be originates from the hydrolysis of urea from dead fish in water and the decomposition of organic waste (Smysem *et al*., 2020).

Annual average of sulfate was 34.1± 5.7 mg/l. whenever alum is added as a coagulant during the treatment process and alkali metal salts are formed, the amount of sulfates in municipal drinking water sources may increase (WHO, 2023).

From the obtained result, the average of residual chlorine 0.5± 0.5 mg/l was lower than that reported (1.3 ±0.4) by (Sakran *et al*., 2019). The highest value of chlorine (1.6 mg/l) was lower than that documented (3.5 mg/l) by (Abou-Dobara *et al*., 2023). Residual chlorine produced from chlorine-containing disinfectants, which include hypochlorite ions, hypochlorous acid, and chloride, induces in a range of toxicological impacts on unwanted organisms (Ding et al., 2020). The free residual chlorine (FRC) concentrations of 0.2–0.5 mg/L are recommended to safeguard the water against regrowth and recontamination during storage and usage, however bacterial regrowth has been found at the recommended FRC levels within this range (Nielsen et al., 2022). Drinking water chlorination has long been regarded as an accurate indicator of water quality in distribution networks (Lienyao et al., 2004).

Although iron is regarded as a secondary or cosmetic contaminant, it is not harmful to health. Iron levels in drinking water are typically less than 0.3 mg/l, but they may be greater in nations where cast iron, steel, and galvanized iron pipes are used for water distribution and where different iron salts are utilized as coagulating agents in water treatment facilities (Swelam *et al*., 2022). In the present study, the average value of iron was 0.019± 0.01 mg/l which was lower than that reported (0.089 ±0.097) by (Sakran *et al*., 2019).

The concentration value (0.003± 0.005 mg/l) of cadmium of tap water samples was lower than that obtained (2.16±1.75 mg/l) by (Mahmoud *et al*., 2018). The mean value (0.07± 0.03 mg/l) of zinc was lower than that obtained (16.11± 23.21 mg/l) by (Mahmoud *et al*., 2018).

Bacterial concentrations in water distribution systems are affected by various water parameters including disinfectant residues, availability of biodegradable nutrients, pipe material and roughness, surface area to volume ratio, stagnation, temperature and hydraulic changes (Abou-Dobara *et al*., 2023). There must be any bacterial contamination in drinking water. Similarly, there was little amount of total plate count (TPC) with an average of 23.4± 8.1 CFU/100ml which is still falls within the permissible limit according to (WHO, 2017). According to Marciano-Cabral et al. (2010), microorganisms can penetrate water utility distribution networks and, consequently, the plumbing within building premises, even if drinking water in the USA is effectively treated. Furthermore, the formation of biofilm may explain why microorganisms continue to exist in the distribution system.

Estimation of water quality index

Assessment of tap water quality according to drinking purposes was applied by using water quality index. The values of WQI of tap water, as indicated in Table (3), showed that The estimated WQI values of all networks had been presented in a good quality, in contrast to (Swelam *et al*., 2022; Karen *et al*., 2021 and Smysem *et al*., 2020).

Estimation of pollution index

In addition, the current study was expanded to assess water pollution caused by heavy metals, specifically iron (Fe^{2+}), lead (Pb^{2+}), zinc (Zn^{2+}), and cadmium (Cd^{2+}). This evaluation was conducted by calculating the Pollution index (PI). The findings presented in Table (4) demonstrate that there was no effect of metals on all distribution networks, which is in contrast to that documented by (Gad *et al*., 2022).

Statistical Analysis

Correlation matrix

Pearson’s correlation coefficient in (Table 5) was used to assess the relationship between tap water characteristics under different conditions in the different distribution networks. There was a strong negative correlation between residual Cl and pH and Zn concentration in the distributed water, r = -.751 and -.755 respectively, p = 0.05, but there was a strong positive correlation between it and total bacterial count r =.718, p = 0.05. There was also a strong negative correlation between TDS and Mg, Ca and Cd concentration in the distributed water, (r = -.794, -.757 and -.757) respectively, at p = 0.05, while it showed a strong positive correlation with total bacteria count r =.718, p = 0.05. on the other hand, alkalinity showed only a strong positive correlation with ammonia r =.735, p = 0.05. Total hardness also confirmed a strong positive correlation with Ca hardness and Mg hardness in water through different network r = -.881 and -.777 respectively, p = 0.01, while Mg exhibited a strong positive correlation with Zn (r = 0.827, p= 0.01). Likewise, iron demonstrate moderate a positive correlation with total hardness (r=0.676, p= 0.05) and a strong positive correlation with Mg hardness (r=0.676, p= 0.05).

Table (5): Correlation matrix analysis of Drinking water parameters (tap water)

		R.	(Tu	rPH	C°	TD	Ch	Al	To	Ca	Ma	Ca	Ma	Am	Su	Ir	Le	Ca	Zi	to
R.Cl	Pearson Correlation	1	.163	-.755*	-.462	.412	.449	.369	.341	.48	.038	.543	-.608	.112	.505	-.372	.437	-.148	-.751*	.718*
	Sig. (2-tailed)		.675	.019	.211	.271	.226	.328	.369	.18	.922	.131	.082	.775	.165	.324	.239	.703	.020	.029
Turbidity (NTU)	Pearson Correlation	.163	1	-.120	-.419	.007	.540	.239	-.204	-.09	-.291	.290	-.101	-.211	-.451	-.109	-.283	-.188	-.520	-.146
	Sig. (2-tailed)	.675		.759	.262	.985	.133	.536	.599	.81	.447	.449	.795	.586	.223	.780	.460	.628	.152	.708
PH	Pearson Correlation	-.755*	-.120	1	.736*	-.178	-.351	-.132	-.433	-.34	-.267	-.646	.327	.125	-.542	.555	-.118	-.101	.530	-.570
	Sig. (2-tailed)	.019	.759		.024	.647	.355	.735	.244	.37	.487	.060	.391	.749	.132	.121	.762	.795	.142	.109
C°	Pearson Correlation	-.462	-.419	.736*	1	-.014	-.148	.130	-.372	-.28	-.157	-.606	.338	.459	-.153	.442	.391	-.080	.587	-.034
	Sig. (2-tailed)	.211	.262	.024		.972	.704	.738	.324	.45	.687	.084	.373	.214	.694	.234	.298	.839	.097	.930
TDS	Pearson Correlation	.412	.007	-.178	-.014	1	-.070	.092	-.241	-.33	-.194	-.219	-.794*	.269	.460	-.142	.102	-.757*	-.478	.708*
	Sig. (2-tailed)	.271	.985	.647	.972		.857	.814	.532	.37	.617	.572	.011	.483	.212	.716	.794	.018	.193	.033
Chlorides	Pearson Correlation	.449	.540	-.351	-.148	-.070	1	.403	-.079	.34	-.171	.385	.114	.278	.080	-.345	.175	-.075	-.277	.207
	Sig. (2-tailed)	.226	.133	.355	.704	.857		.282	.840	.36	.660	.306	.770	.469	.838	.363	.652	.848	.470	.592
Alkalinity	Pearson Correlation	.369	.239	-.132	.130	.092	.403	1	.519	.46	.532	-.284	.163	.735*	-.316	-.588	.498	.194	.008	.459
	Sig. (2-tailed)	.328	.536	.735	.738	.814	.282		.152	.21	.141	.459	.676	.024	.408	.096	.172	.617	.984	.214
Total Hardness	Pearson Correlation	.341	-.204	-.433	-.372	-.241	-.079	.519	1	.77*	.881**	-.003	.177	.286	-.083	-.676*	.227	.612	.097	.201
	Sig. (2-tailed)	.369	.599	.244	.324	.532	.840	.152		.01	.002	.994	.649	.456	.832	.046	.557	.080	.803	.605
Calcium Hardness	Pearson Correlation	.485	-.092	-.340	-.286	-.338	.344	.461	.777*	1	.513	.193	.173	.337	.038	-.537	.329	.443	-.010	.101
	Sig. (2-tailed)	.186	.814	.371	.455	.374	.364	.211	.014		.158	.619	.655	.376	.923	.136	.387	.232	.980	.797
agnesium Hardness	Pearson Correlation	.038	-.291	-.267	-.157	-.194	-.171	.532	.881**	.51	1	-.295	.348	.458	-.200	-.735*	.051	.651	.369	.158
	Sig. (2-tailed)	.922	.447	.487	.687	.617	.660	.141	.002	.16		.440	.359	.215	.605	.024	.897	.058	.328	.684
Calcium	Pearson Correlation	.543	.290	-.646	-.606	-.219	.385	-.284	-.003	.19	-.295	1	-.272	-.632	.318	.121	-.045	.172	-.638	.008
	Sig. (2-tailed)	.131	.449	.060	.084	.572	.306	.459	.994	.62	.440		.480	.068	.404	.756	.908	.658	.065	.983
agnesium	Pearson Correlation	-.608	-.101	.327	.338	-.794*	.114	.163	.177	.17	.348	-.272	1	.195	-.461	-.082	.027	.576	.827**	-.486
	Sig. (2-tailed)	.082	.795	.391	.373	.011	.770	.676	.649	.65	.359	.480		.615	.211	.834	.945	.104	.006	.185
Ammonia	Pearson Correlation	.112	-.211	.125	.459	.269	.278	.735*	.286	.34	.458	-.632	.195	1	-.017	-.555	.405	-.037	.354	.455
	Sig. (2-tailed)	.775	.586	.749	.214	.483	.469	.024	.456	.37	.215	.068	.615		.965	.121	.280	.925	.351	.218
Sulphate	Pearson Correlation	.505	-.451	-.542	-.153	.460	.080	-.316	-.083	.038	-.200	.318	-.461	-.017	1	-.061	.316	-.415	-.253	.617
	Sig. (2-tailed)	.165	.223	.132	.694	.212	.838	.408	.832	.92	.605	.404	.211	.965		.875	.408	.267	.512	.077
Iron	Pearson Correlation	-.372	-.109	.555	.442	-.142	-.345	-.588	-.676*	-.53	-.735*	.121	-.082	-.555	-.061	1	.019	-.194	.000	-.411
	Sig. (2-tailed)	.324	.780	.121	.234	.716	.363	.096	.046	.13	.024	.756	.834	.121	.875		.962	.617	1.000	.272
Lead	Pearson Correlation	.437	-.283	-.118	.391	.102	.175	.498	.227	.32	.051	-.045	.027	.405	.316	.019	1	-.084	.048	.610
	Sig. (2-tailed)	.239	.460	.762	.298	.794	.652	.172	.557	.38	.897	.908	.945	.280	.408	.962		.829	.903	.081
Cadmium	Pearson Correlation	-.148	-.188	-.101	-.080	-.757*	-.075	.194	.612	.44	.651	.172	.576	-.037	-.415	-.194	-.084	1	.352	-.363
	Sig. (2-tailed)	.703	.628	.795	.839	.018	.848	.617	.080	.23	.058	.658	.104	.925	.267	.617	.829		.353	.338
Zinc	Pearson Correlation	-.751*	-.520	.530	.587	-.478	-.277	.008	.097	-.01	.369	-.638	.827**	.354	-.253	.000	.048	.352	1	-.355
	Sig. (2-tailed)	.020	.152	.142	.097	.193	.470	.984	.803	.98	.328	.065	.006	.351	.512	1.000	.903	.353		.349
total plate count	Pearson Correlation	.718*	-.146	-.570	-.034	.708*	.207	.459	.201	.10	.158	.008	-.486	.455	.617	-.411	.610	-.363	-.355	1
	Sig. (2-tailed)	.029	.708	.109	.930	.033	.592	.214	.605	.79	.684	.983	.185	.218	.077	.272	.081	.338	.349	

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).
N= 9

Multivariate clustering dendrogram (Figure 2) revealed relatively similar results to correlation coefficient values as the first cluster comprised total hardness, TDS, Mg hardness, Ca hardness and EC, while the second cluster included Ca, Mg, total bacteria count, temperature, Mg, pH, Zn, residual Chlorine, turbidity, chloride, sulfate and Cd. Moreover, total hardness stood in a distinctive cluster. The first and second clusters could be divided into two sub-clusters which Mg hardness and temperature formed up a separate sub-cluster, respectively. Overall, these results intimated the important water quality elements that should be considered in the drinking water distribution network under different conditions.

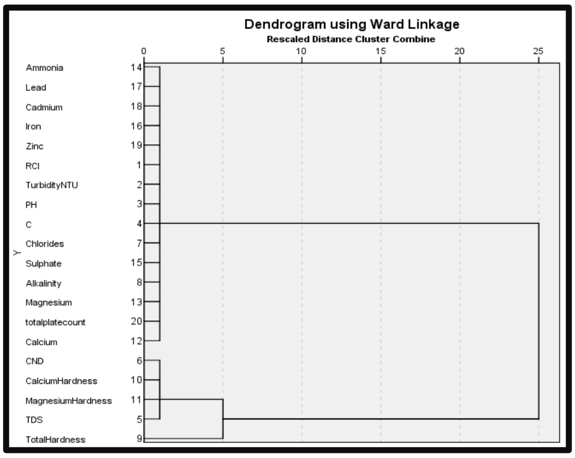

Figure (2): The dendrogram illustrating the clustering of physicochemical and bacteriological parameters of tap water distribution networks in the study area.

Statistical Analysis (ANOVA Test)

The study evaluated the tap water quality using a one-way analysis of variance (ANOVA) with between-subjects design. The evaluation was depended on the concentration of heavy metals, physicochemical parameters and biological parameters of water in the distribution networks. Statistically there were no significant differences among the various groups of all points of distribution under different conditions. These differences were examined for various parameters including turbidity, temperature, pH, EC, total hardness, TDS, chlorides, sulfates, calcium, magnesium, iron, lead, cadmium, and zinc as shown in Table (6).

Table (6) Statistical Analysis (ANOVA Test)

	Sum of Squares	df	Mean Square	F	Sig.
Distribution Network					
Between Groups	1068.033	160	6.675	.961	.582
Within Groups	131.967	19	6.946		
Total	1200.000	179			
Parameters					
Between Groups	10735.525	8	1341.941	.062	1.000
Within Groups	3679816.011	171	21519.392		
Total	3690551.536	179			

Conclusion

Access to clean water in appropriate amounts for drinking, sustaining personal hygiene, cooking and sanitation is one of the most fundamental humans Right. This study audited the drinking water quality of some distribution networks (household tap water) of treatment plants located at River Nile by applying physicochemical analysis, total plate count for biological parameters, some models like water quality index and pollution index. The obtained results indicated that every physicochemical parameter and heavy metal that was examined fell within the WHO's allowable limits for drinking water. WQI index revealed that the quality of all distribution networks for each plant during the study period was good. According to PI, all specified heavy metals hadn't impact on tap waters. The study recommends regular monitoring and auditing the quality of drinking water to avoid waterborne diseases and keep the consumers' health starting from the source intake (River Nile and its branches), treatment plants, purification stages like filtration and disinfection, transformation to the distributed pipes to the final stage households of the consumers as a final product to insure sustainable and safe water.

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References

Abou-Dobara, I.M.; Ghaly, F.M.; Abd – El Aziz, H.M. & Ahmed, H.E. (2023). Bacterial Distribution and Physico-Chemical Studies on Drinking Water from Different Sites in Zagazig City (El-Sharkia Governorate). Scientific Journal for Damietta Faculty of Science 13(1): 90-101.

Afifi, M. A., El-Emam, D. A., Abdel Wahaab, R., & Ibrahim, M. S. (2023). Efficient Ammonia Removal in the Rosetta Branch of the River Nile using Activated Carbon: A Comprehensive

Study. Egyptian Journal of Chemistry.

APHA, (Amercian puplic health association), (2017). American water work association (AWWA), and water environmental federation. Standard methods for the examination of water and waste water, 23 th Ed., American puplic health association, Washington, 209-216.

Adjovu, G. E.; Stephen, H.; James, D. & Ahmad, S. (2023). Measurement of total dissolved solids and total suspended solids in water systems: A Review of the Issues, Conventional, and Remote Sensing Techniques. Remote Sensing, 15(14):3534.

Alver, A. (2019). Evaluation of conventional drinking water treatment plant efficiency according to water quality index and health risk assessment. Environmental Science and Pollution Research, 26(26):27225-27238.

Akoto, O.; Opoku, G.; Darko, G. and Barnes, V. R. (2017). Changes in water quality in the Owabi water treatment plant in Ghana. Appl. Water Sci. 175–186.

Arunkumar, M., & Mariappan, V. N. (2011). Water demand analysis of municipal water supply using epanet software. International Journal on Applied Bioengineering, 5 (1), 9-19.

Badr S. A.; El-Sonbati, M.A. and Nassef, H.M. (2013). Water Quality Assessment in the Nile River, Damietta Branch, Egypt, The Egyptian Society for Environmental Sciences. 8 (1): 41-50.

Banna, M. H.; Najjaran, H.; Sadiq, R.; Imran, S. A.; Rodriguez, M. J. And Hoorfar, M. (2014). Miniaturized water quality monitoring pH and conductivity sensors. Sensors and Actuators B: Chemical, 193:434-441.

Besner, M.-C.; Prévost, M. and Regli, S. (2011). Assessing the public health risk of microbial intrusion events in distribution systems: Conceptual model, available data, and challenges. Water Research, 45 (3), 961–979. https://doi.org/10.1016/j.watres.2010.10.035

Brossia, S. (2018). Corrosion of pipes in drinking water systems. In Handbook of Environmental Degradation of Materials (pp. 489-505). William Andrew Publishing.

Bazgir, A.B.; Mohammadi, H.; Pirsaraei, S. R. (2020). Risk assessment of drinking water supply and distribution system of Zanjan City from Tahm dam using water safety plan. Desalination and Water Treatment. doi: 10.5004/dwt. 26419.

Dandge, KP.; Patil, SS. (2022) . Spatial distribution of groundwater quality index using remote sensing and GIS techniques. Applied Water Science; 12(7): 1–18.

De Santi, M.; Ali, S.; Arnold, M.; Fesselet, J.; Hyvarinen, AM.; Taylor, D, et al. (2022). Modelling point-of-consumption residual chlorine in humanitarian response: Can cost-sensitive learning improve probabilistic forecasts? PLOS Water 1(9): e0000040. https://doi.org/10.1371/journal. pwat.0000040.

Ding, X.; Zhu, J.; Zhang, J.; Dong, T.; Xia, Y.; Jiao, J.; Wang, X. & Zhou, W. (2020). Developmental toxicity of disinfection by-product monohaloacetamides in embryo-larval stage of zebrafish. Ecotoxicol. Environ. Saf ,189.

Dutt, V. & Sharma, N. (2022). Potable water quality assessment of traditionally used springs in a hilly town of Bhaderwah, Jammu and Kashmir, India. Environmental monitoring and assessment, 194(1):30.

El-Emam, D. A. (2020). Monitoring and Assessment of Water Pollution in River Nile–Damietta Branch-Egypte. A Ph. D thesis in Science Environmental Science/Environmental Quality Monitoring Environmental Sciences Department Faculty of Science, Damietta University, Egypte.

Elemam, D., & Eldeeb, A. (2023). Climate change in the coastal areas: consequences, adaptations, and projections for the Northern Coastal Area, Egypt. Scientific Journal for Damietta Faculty of Science, 13(2), 19-29. doi: 10.21608/sjdfs.2023.170018.1061

Eslami, A.; Ghaffari, M.; Barikbin, B. & Fanaei, F. (2018) Assessment of safety in drinking water supply system of Birjand city using World Health Organization’s water safety plan, Environ. Health Eng. Manage. J., 5, 39–47 (in Persian).

García-Ávila, F.; Zhindón-Arévalo, C.; Valdiviezo-Gonzales, L.; Cadme-Galabay, M.; Gutiérrez-Ortega, H. & Del Pino, L. F. (2022). A comparative study of water quality using two quality indices and a risk index in a drinking water distribution network. Environmental Technology Reviews, 11(1):49-61.

Gad, M.; Saleh, A. H.; Hussein, H.; Farouk, M. & Elsayed, S. (2022). Appraisal of surface water quality of nile river using water quality indices, spectral signature and multivariate modeling. Water, 14(7):1131.

Golicha, Q.; Shetty, S.; Nasiblov, O.; Hussein, A.; Wainaina, E.; Obonyo, M. et al. (2018). Cholera outbreak in Dadaab Refugee camp, Kenya— Rep. 67: 958– 961.

Hossain, M.B; Roy, N.; Biswas, P.; Azad, M.N. & Yusuf, E. (2021). Analysis and Design of Water Distribution Network Using EPANET: A Case Study of HSTU Campus of Dinajpur, Bangladesh. Hydrology; 9(2): 36-47.

Karen, V Y T. ; Kamarudzaman, A N. , Abd Jalil, M F. ; Hassan, Z. ; Mahyun A.W. ; Salwa, M.Z.M. & Amirah A.S.N. (2021). Assessment of drinking water quality for raw water and treated water at Kangar, Perlis, Malaysia. International Conference on Civil and Environmental Engineering. IOP Conf. Series: Earth and Environmental Science, 646: 012011. doi:10.1088/1755-1315/646/1/012011.

Kirk, M.D.; Angulo, F.J. ; Havelaar, A.H. & Black, R.E. (2017). Diarrhoeal disease in children due to contaminated food, Bull. World Health Organ, 95,233–234.

Kouassi, A. A. M., Kouassi, K. L., & Gnagne, T. (2023). Impact of the Condition of Drinking Water Supply Networks on the Quality of Water Intended for Consumption: The Case of the Network in the Commune of Daloa (Central West of Côte d'Ivoire). Journal of Water Resource and Protection, 15(12), 677-691.

Kumpel, E.; Delaire, C.; Peletz, R.; Kisiangani, J.; Rinehold, A.; De France, J.; Sutherland, D. & Khush, R. (2018). Measuring the impacts of water safety plans in the Asia-Pacific region, Int. J. Environ. Res. Public Health, 15: 1–8, doi:10.3390/ijerph15061223.

Lienyao, L.; Chungsying, L. & Shyang-Lai; K. (2004). Spatial diversity of chlorine residual in a drinking water distribution system. Journal of Environmental Engineering, 130, 1263–1268.

Mahmoud, M.T.; Hamouda, M.A.; Al Kendi, R. & Mohamed, M. (2018). Water 10, 1726; doi:10.3390/w10121726.

Manna, A. & Biswas, D. (2023). Assessment of Drinking Water Quality Using Water Quality Index: A Review. Water Conservation Science and Engineering, 8(1):6.

Marciano-Cabral; Jamerson, F. M. & Kaneshiro, E.S. (2010). Free-living amoebae, Legionella and Mycobacterium in tap water supplied by a municipal drinking water utility in the USA. J Water Health. 8(1): 71- 82.

Martinez, F., Conejos, P., & Vercher, J. (1999). Developing an integrated model for water distribution systems considering both distributed leakage and pressure-dependent demands. In WRPMD'99: Preparing for the 21st Century (pp. 1-14).

Meran, G., Siehlow, M., & von Hirschhausen, C. (2021). Pipes, Taps, and Vendors: An Integrated Water Management Approach. Water Economics and Policy, 7(04), 2150018.Roeger, A. & Tavares, A.F. (2018). Water safety plans by utilities: a review of research on implementation, Util. Policy, 53, 15–24.

Nielsen, A.M., Garcia, L.A.T., Silva, K.J.S., Byrne, J.A. & Fernández-Ibáñez, P. (2022). Chlorination for low-cost household water disinfection – A critical review and status in three Latin American countries. International Journal of Hygiene and Environmental Health , 244, 114004.

Sakran, T.; Matooq, P.; El-Shahawy, G. ; Shalaby, M. ; Sabry, H. & Gad, M. (2019). Monitoring Water Quality Parameters in Egyptian Tap Water. Pol. J. Environ. Stud. Vol. 28, No. 4, 2815-2821. DOI: 10.15244/pjoes/92820.

Smysem, I. H.; Khidr, A. A. A.; Bahnasawy, M. H. & El-Komi, M. M. (2020). Assessment of Surface Water Quality in the Damietta Branch of Nile River, Egypt. Scientific Journal for Damietta Faculty of Science, 10(1):1-12.

Swelam, H. S.; El Shazly, M. M.; Mekal, A. D. & Marzouk, E. R. (2022). Drinking water biological and chemical contaminants: a case study of rural areas of northwest sinai, egypt. Sinai Journal of Applied Sciences, 11(2):271-292.

Şener, Ş.; Şener, E. & Davraz, A. (2017). Evaluation of water quality using water quality index (WQI) method and GIS in Aksu river (SW-Turkey). Science of the Total Environment; 584–585: 131–144. doi: 10.1016/j.scitotenv.2017.01.102.

Tiwari, T. N., and Manzoor, A. (1988). Water Quality Index for Indian Rivers. In: Ecology and Pollution of Indian River. Ashish Publishing House, New Delhi: 271- 286.

World Health Organization (WHO). (2011). "Guidelines for drinking water quality, 4th ed. Geneva: WHO, 564p. ISBN: 978 92 4 154815 1.

World Health Organization (WHO). (2017). Guidelines for Drinking-Water Quality, 4th ed., World Health Organization, Geneva.

Yang, J.; LeChevallier, M.W.; Teunis, P.F.M. & Xu, M. (2011). Managing risks from virus intrusion into water distribution systems due to pressure transients. Journal of Water and Health, 9 (2), 291– 305.

الملخص العربي

عنوان البحث: مراقبة جودة مياه الصنبور ببعض شبكات التوزيع بمحافظة دمياط

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تعد جودة مياه الشرب مؤشرا بيئيا هاما على صحة الإنسان. تعد إدارة جودة مياه الشرب أساس الوقاية من الأمراض المنقولة بالمياه ومكافحتها وغيرها من الملوثات أو السموم. يعد تدقيق جودة المياه نهجًا إداريًا حاسمًا للحفاظ على المياه بكفاءة. ولذلك تم تنفيذ العمل الحالي لتقييم بعض الجودة الفيزيائية والكيميائية والبيولوجية لمياه الشرب في نهاية شبكات التوزيع (مياه الصنبور) في بعض نقاط الشبكة في محافظة دمياط. تم جمع تسع عينات من ٣ شبكات توزيع لـ ٣ محطات معالجة تقع على نهر النيل موسمياً على مدار عام ٢٠٢١ وإخضاعها للتحليل لمختلف الخصائص الفيزيائية والكيميائية والبيولوجية، بالإضافة إلى بعض المعادن الثقيلة.

تم تطبيق مقاييس التلوث بالمعادن الثقيلة (PI) وجودة المياه (WQI) لتقييم حالة المياه. علاوة على ذلك، تم تنفيذ تحليل التباين (ANOVA) أحادي الاتجاه لمقارنة التباين الزماني والمكاني لـ WQI. أظهرت النتيجة أن متوسط قيمة العكارة والتوصيل الكهربائي ودرجة الحموضة والصلابة الكلية للمواد الصلبة الذائبة والصلابة الكلية لمياه الصنبور كانت ٠,٦±٠,٢ NTU، ٢٩٦,٢ ±١٩,٨ µmohs/cm، ٧,٢±٠,١٤، ١٨٣,٣±٤,٣ و٥٢٨±٢١٢ ملجم/ سم. ل، على التوالي. بالإضافة إلى ذلك، كانت تركيزات الأمونيا والكلور المتبقي والكلوريدات والكبريتات والكالسيوم والمغنيسيوم والحديد والرصاص والكادميوم والزنك ٠,٠١٤ ± ٠,٠١، ٠,٥ ± ٠,٥،٣٥,٣ ± ٦,٣، ٣٤,١ ± ٥,٧،٦٣,٤ ± ١٧،٢٣,٢ ± ٤,٨، ٠,٠٢ ±٠,٠١، ٠,٠١±٠,٠١، ٠,٠٠٣±٠,٠٠٥، ٠,٠٧±٠,٠٣ ملغم/لتر، على التوالي. كان العد البيكتيري الكلي ٢٣,٤ ± ٨,١ CFU / 100 مل. أظهرت النتائج التي تم الحصول عليها أن العد البيكتيري المقاس كان في الحدود المسموح بها وفقا لمنظمة الصحة العالمية (٢٠١٧). أكدت قيم متوسط مؤشر جودة المياه (٥٦,٦، ٥٦,٥٨، ٥٢,٩، على التوالي) لشبكات التوزيع ١ و ٢ و ٣ أن مياه الصنبور في منطقة الدراسة كانت ذات نوعية جيدة. توصي هذه الدراسة بالصيانة المستمرة لأنابيب المياه من خلال شبكات التوزيع لتجنب تلوث المياه وحماية مصدر المياه لتلبية المعايير الدولية.