

## Quality of drinking water in al-Sadr city in Baghdad city

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### Abstract:

The quality of drinking water supplied to households plays an important role in public health. The length and quality of the water distribution networks play an important role in the quality of water. The studies that highlight the quality of drinking water supplied to the most densely populated in Baghdad (Al-Sadr City), as well as the relationship between the length of the drinking water distribution network and the quality of water are scanty in literature. The current study cove this gap. In the current study 170, tap water samples from 17 different areas of Sadr City, Baghdad, Iraq which is at different distances from the drinking water distribution station were collected. The pH, Total hardness, and concentrations of Chloride, Nitrite, Nitrate, Sulfite, Sulfate, Calcium, Magnesium, Iron, Lead, and Phosphate were measured. Proving bacterial contamination by conducting bacteriological tests (coliforms) was studied also. The results showed that five isolates of non-fecal coliform were isolated from samples collected from the areas furthest from the distribution station. The results showed that the specifications of the drinking water taken were within the standard specifications. The results also clearly showed the effect of the length of the distribution network on the water quality. Negative relationship ( $P < 0.05$ ) between the distance of distribution station (DDS) of water and pH values, total hardness, concentrations of chloride, and phosphate. The results also showed a positive relationship between DDS and concentrations of nitrites and sulfites, magnesium, and iron. There was no relationship between DDS and concentrations of nitrates, sulfates, and lead. It can be concluded from the current study that the length of the water distribution network has a major role in changing the specifications and quality of drinking water distributed to Al-Sadr City houses.

**Keywords:** Coliform, Distance of distribution station (DDS), Public health, Quality of water, SADR city.

## 1. Introduction

The quality of drinking water distributed through pipes to house are directly related to public health. This is not limited to human health, but also the health of domestic animals and pets [1]. The World Health Organization publishes (WHO) published standards for drinking water in general. This publication highlight one chemical content of water such as heavy elements and various chemical compounds, in addition to the physical specifications of water. Moreover, the WHO provides various publications highlighting water microbial contamination [2]. The microbial content of drinking water is directly related to public health and plays an important role in the occurrence of epidemics that come from water (many water-borne diseases), i.e. cholera, typhoid, and gastrointestinal diseases associated with enter-viruses. Coliform bacteria (Fecal coliform bacteria and non-fecal coliform). They are coming either from the human, and animal intestinal tract, and they are known as a biological indicator of contaminating water with human and animal stool. While the other coliform comes from the environment. Both gives a good indication of the possibility of contamination with microbes [3].

Many previous studies investigated the pollution of water and sewage water in Iraq with chemical components and biological agents [4, 5]. Other investigators studied the standard specifications of tap water (drinking water) in addition to bottled water in the city of Baghdad and a number of other provinces [5]. However, there is no previous study that highlighted the effect of the distance of water distribution stations on the quality of drinking water that reaches house. As we know the age and type of drinking water distribution pipes and their quality for water transfer plays a central role in the quality of water supplied to house [6].

## 2. Problem:

The current study is one of the unique studies that focus on the quality of drinking water supplied to house in the Al-Sadr City in Baghdad, which are areas known for their overcrowding, in addition to the old water distribution networks, and inhabited by people with low incomes. That is why the tap water may represent the main source of drinking water because residents cannot buy sterile bottled water.

## 3. Hypothesis

The current study on the quality of water supplied to the residents of al-Sadr City raises many questions:

1. Is the quality of the supplied water within the standard specifications approved by the WHO?

2 . Is the quality of water supplied to the residents of Al-Sadr City affected by its distance from the water distribution station?

#### 4. Aims

The current study aims to estimate the quality of drinking tap water supplied to areas in Al-Sadr City in Baghdad, in addition to estimating the effect of the length of the distribution network of pipes on the quality of water supplies to house.

#### 5. Methodology

##### 5.1. Study area

The study area is located in the northeastern part of the city of Baghdad, specifically east of the main water channel (Al-Sadr City). Which is characterized by a high population density in addition to a low standard of living. The study area is surrounded by residential neighborhoods on three sides, while the remote areas of the study area are bordered by agricultural areas. In this study, the city was divided into seventeen districts, which are located at different distances from the drinking water distribution station. The area of study was around 50 Km<sup>2</sup>.

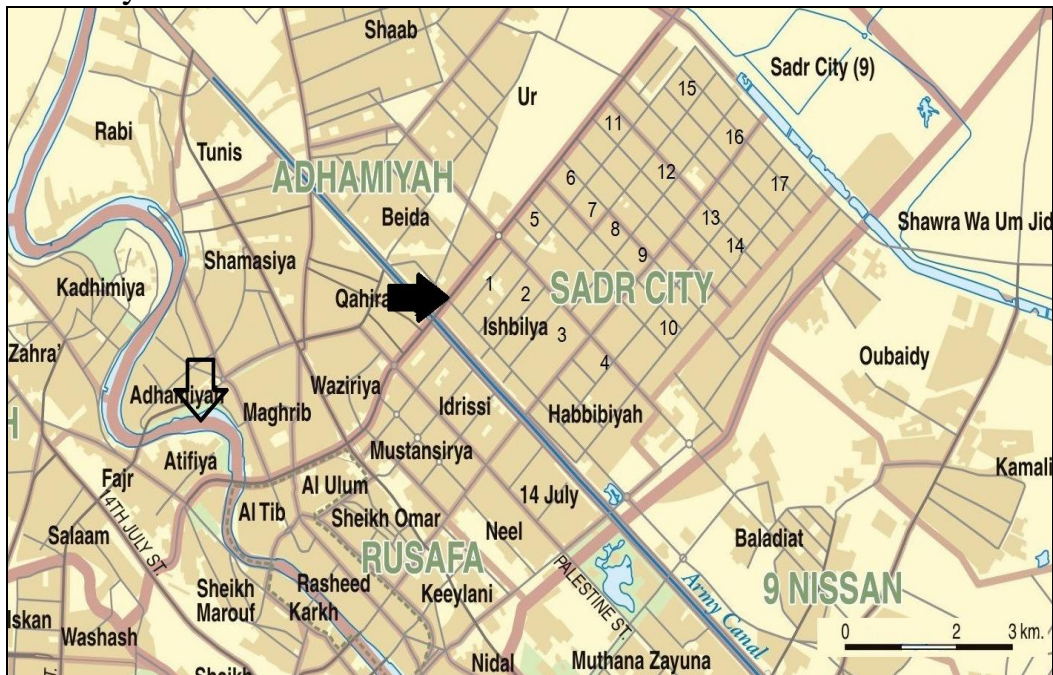


Fig. 1. Map of study area (Al-Sadr City) that divided into 17 districts. The filled black arrow indicates the drinking water distribution station. The empty black arrow points to the Tigris River.

### 5.2. *Sample Collection*

A hundred seventy tap water samples were included in the current study, ten samples were collected from each district. The tap was sterile by flam before sample collection. Fifty ml of tap water was collected in sterilized screw universal glass. The water was transferred immediately to the lab for chemical, physical and microbiological examination. The samples were collected from October 2021 to December 2021. This duration is starting the rainy season, which can be reflected in the groundwater level and thus could affect the interference with the drinking water distribution network in the event of any erosion or breakage in the network.

### 5.3. *Bacteriological examination*

The standard method of Al-Bayatti et al, (2012) [4] was followed to isolate and identify bacterial isolates from tap water samples. The total bacterial population was determined by standard coliform fermentation technique including presumptive, confirmed, and completed tests [Guidelines for Drinking]. For identification of pathogenic enteric bacteria water samples were spread on Nutrient agar, MacConkey agar, blood agar, eosin-methylene blue agar (EMB), and Thiosulfate citrate bile sucrose agar (TCBS) medium. The plates were incubated overnight at 37°C, and after incubation, cultures were examined for distinct colonies.

### 5.4. *Physical and Chemical Tests*

The standard method of AL-Dulaimi and Younes, (2017) [5] was followed to check the pH, Total hardness, and concentrations of Chloride, Nitrite, Nitrate, Sulfite, Sulfate, Calcium, Magnesium, Iron, Lead, and Phosphate.

### 5.5. *Drinking water guidelines*

World Health Organization guideline (2017) was used to identify the quality of tap water in al-Sadr City, Baghdad, Iraq because it is widely used by various countries and used to determine the quality of the drinking water.

### 5.6. *Statistical analysis*

All values have been used to give a mean value and the standard deviation calculated. The correlation coefficient test (Pearson, r) was used to check the relationship between groups. The differences were analyzed by using Student's t-test and Chi-square test employing Origin version 8.0 software. A value of  $P < 0.05$  was considered to be statistically significant.



## 6. Results

### 6.1. Physicochemical parameters of tap water

Table 1 shows the average values of chemical and physical specifications for tap water collected from different areas of Al-Sadr City. The table shows that all values were within the normal levels determined by the published reports of WHO, and this confirms that the water supplied through the pipe network within the study area was within the acceptable levels that do not negatively affect the public health of its consumers.

**Table 1.** Mean values of the physicochemical parameters of tap water from different districts in Al-Sadr City in Baghdad city and the WHO limits.

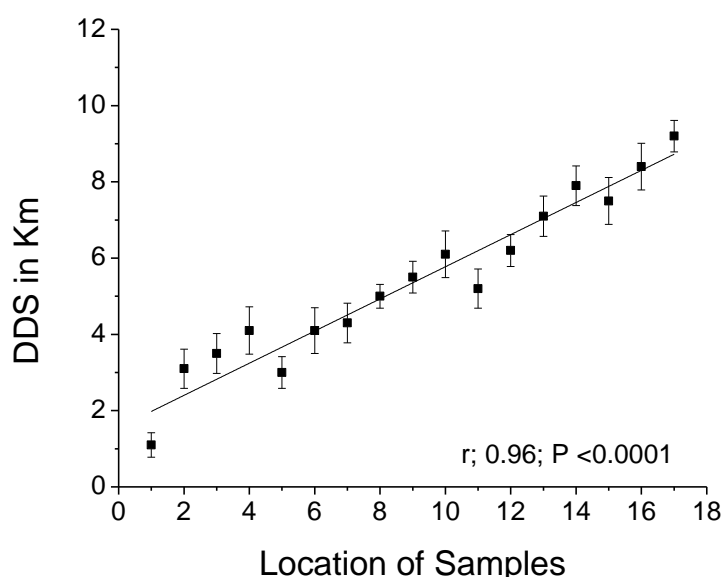
	Physical and chemical parameters	Mean $\pm$ SD (different districts of Al-Sadr City)	WHO GUIDELINES*
1.	pH	7.5 $\pm$ 0.4	6.6-8.5
2.	Chloride, mg/L	178.2 $\pm$ 37.2	250
3.	Total hardness, mg/L	563.5 $\pm$ 133.9	500 ppm as CaCO <sub>3</sub>
4.	Nitrite, mg/L	0.05 $\pm$ 0.006	3
5.	Nitrate, mg/L	0.69 $\pm$ 0.27	50
6.	Sulfite, mg/L	25.2 $\pm$ 4.9	—
7.	Sulfate, mg/L	348.9 $\pm$ 79	500
8.	Calcium, mg/L	62.9 $\pm$ 16	—
9.	Magnesium, mg/L	18.95 $\pm$ 4.7	—
10.	Iron, $\mu$ g/L	90	300
11.	Lead, $\mu$ g/L	0.032 $\pm$ 0.007	0.1
12.	Phosphate mg/ml	0.3 $\pm$ 0.033	1

### 6.2. Bacteriological contains of tap water

The current study showed that out of 170 tap water samples, five samples only gave positive to bacterial isolation test. All bacterial isolates were non-fecal coliforms. The positive samples were in the study area 17 (two isolates), the study area 13 with one isolate, the study area 16 with one isolate, and the study area 9 with only one isolate. The results of this study confirm that the microbial contamination that occurred in some areas of the study was caused by cracks and erosion in some drinking water distribution pipes, and fortunately, this erosion was far from the sewage network, so the contamination that occurred was from soil near the corroded pipes.

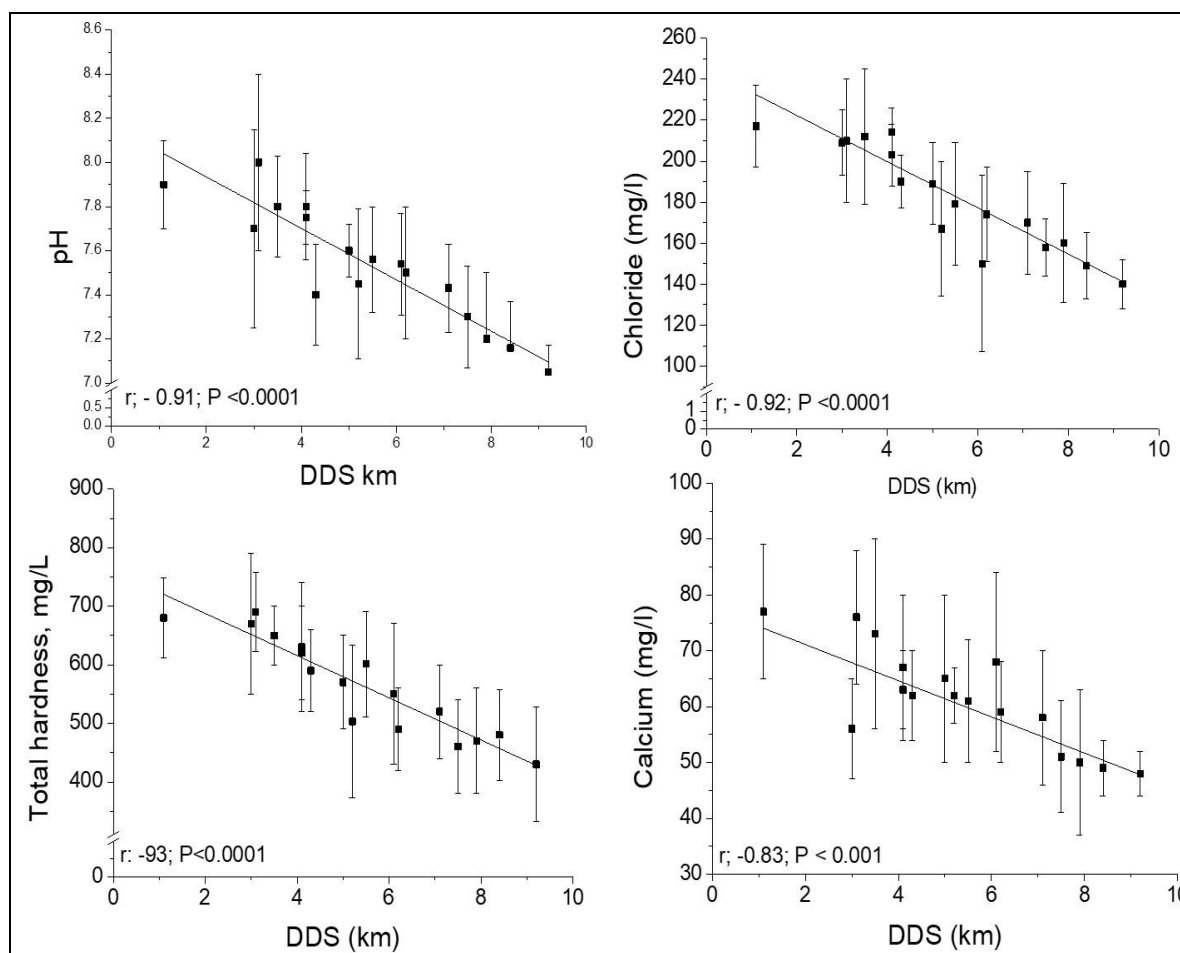
### 6.3. Effect of network length on quality of tap water

In the current study, the areas from which samples were collected were selected with varying distances from the location of the distribution water supply station. Figure 2 shows the significant positive relationship (statistical) between the sample number and its distance from the water supply station ( $r; +0.96; P < 0.0001$ ). This will enable us to compare the water quality with the length of the potable water supply network.



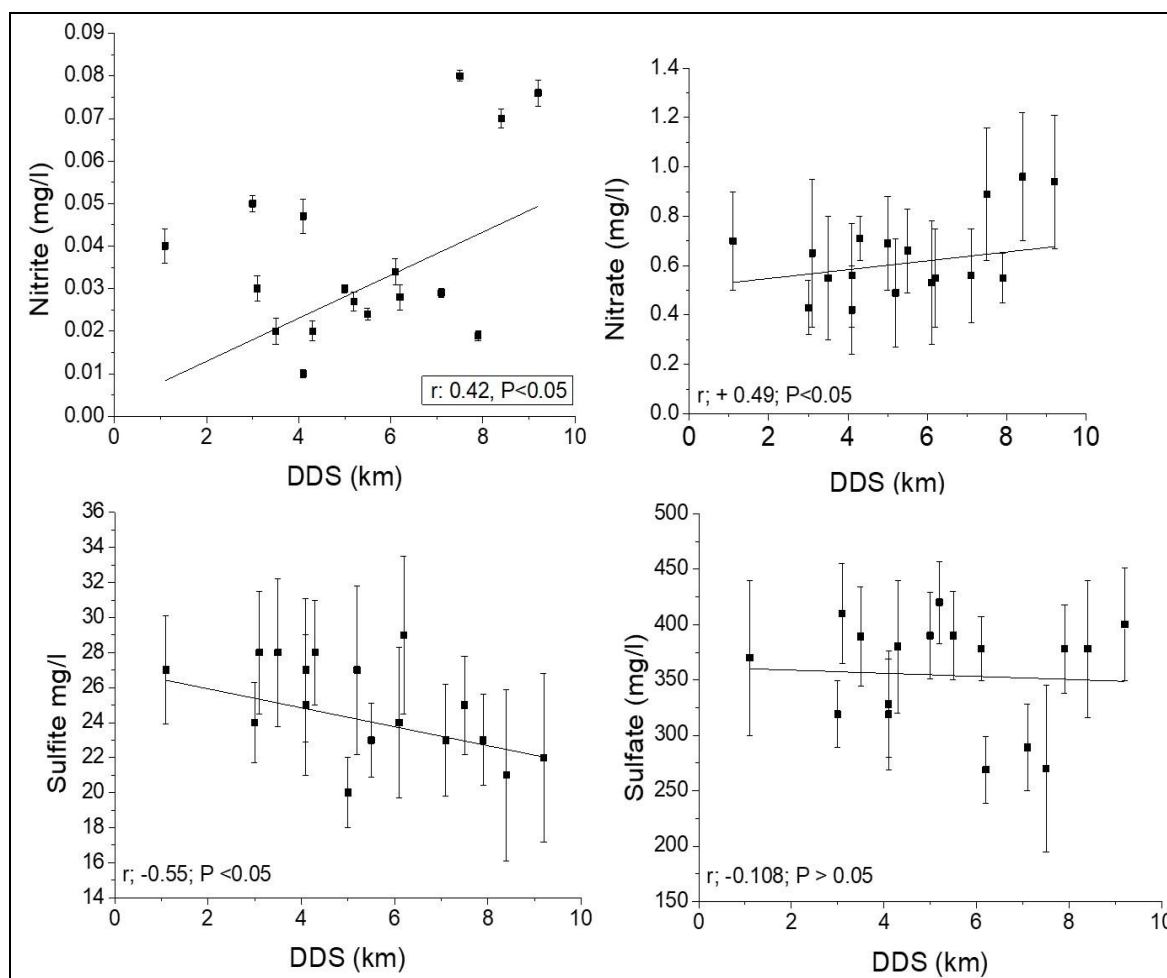
**Fig 2.** The relationship between the distance of the distribution station (DDS) of drinking water and the number of study areas. Pearson Correlation coefficient.

Figure 3 shows the relationship between the distance of the distribution station (DDS), in another hand the length of the water distribution network of pipes with the level of pH value, chlorine concentration, total hardness and calcium concentration. Thus the present study showed the negative statistical relationship between DDS and pH value, chlorine concentration, total hardness and calcium concentration. This indicates that the farther the sampling area is from the water distribution station reduces the pH value, chlorine concentration, calcium concentration and total hardness.



**Fig. 3.** Relationship of between distance of distribution station (DDS) and level of pH value, chlorine concentration, total hardness and calcium concentration. All relations where negative statistical relations ( $P < 0.0001$ ).  $r$ , Pearson Correlation coefficient.

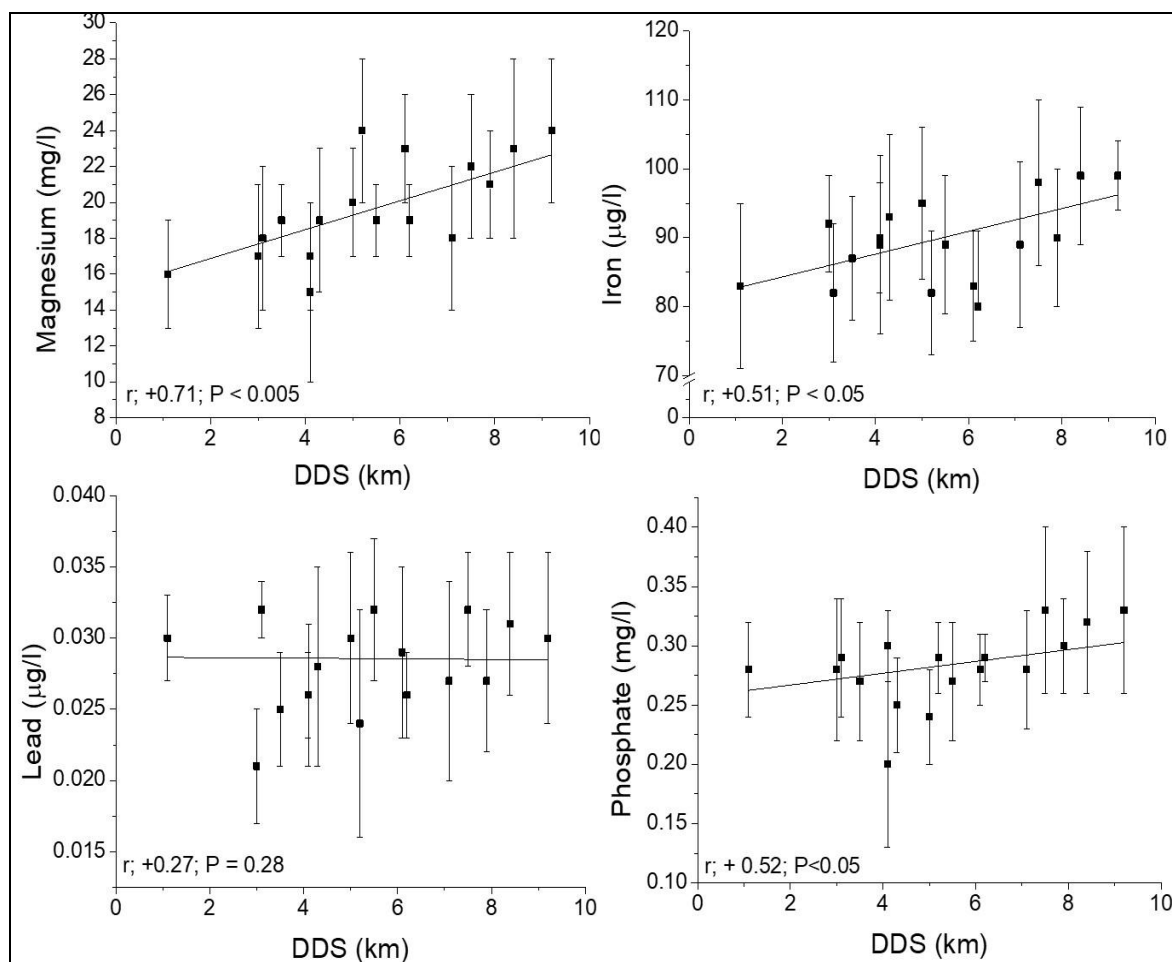
Figure 4 shows relationship of between distance of distribution station (DDS) and concentrations of nitrite, nitrate, sulfite and sulfate. The positive significant relation was observed between DDS and nitrite and nitrate concentrations in samples that collected from different places of studied areas ( $P < 0.05$ ). While negative relationships was seen between DDS and concentration of sulfite ( $P < 0.05$ ). The current study showed no significant relation between DDS and sulfate concentration that collected from different studies areas.



**Fig. 4.** Relationship of between distance of distribution station (DDS) and concentrations of nitrite, nitrate, sulfite and sulfate.  $r$ , Pearson Correlation coefficient.

Figure 5 shows relationship of between DDS and concentrations of magnesium (Mg), Iron, Lead and phosphate. The positive significant relation was observed between DDS and concentrations of Mg and Iron in samples that collected from different places of studied areas ( $P < 0.05$ ). While negative relationships was seen between DDS and concentration of phosphate ( $P < 0.05$ ). The current study showed no significant relation between DDS and concentration of lead that collected from different studies areas.





**Fig. 5.** Shows a relationship of between DDS and concentrations of magnesium (Mg), Iron, Lead, and phosphate. R, Pearson Correlation coefficient.

The present study proves the hypothesis regarding the quality of water supplied to Al-Sadr City was within the standards of the WHO. Moreover, the present study proved that distance of the distribution station affects the quality of water but they were within the standards of WHO. That proves the hypothesis raised in the current study.

### 7. Discussion

The quality of drinking water supplied to households plays a major role in public health. The study of specifications and quality of drinking water is one of the most important scientific research related directly to human and animal health alike [7,8]. There are many studies that dealt with the quality of drinking water in the world and Iraq in particular [5, 8]. Many researchers have shed light on the quality of drinking water in Baghdad, but the studies that deal with the quality of drinking water supplied through the network of

pipes are very few [5]. The quality of water distribution pipes plays an important role in the quality of drinking water destined for residential areas [9].

Our current study dealt with the quality of drinking water supplied to homes in one of the most densely populated areas in Baghdad city. The tap water samples were collected from areas at different distances from the drinking water distribution station of the Al-Sadr district. The study showed that water specifications were within the standard specifications, but the proportion of chemical compounds, biological content and physical specifications were different from one region to another.

The study showed that the increase in distance between the water distribution station and houses will affect negatively affected on water quality. It was noted that the lowest water quality was in the areas farthest from the water distribution station, even indicators of biological pollution (coliform) were monitored in the study areas farthest from the water distribution station.

What has been achieved explains that the length of the water distribution network will increase the possibility of erosion and breakage of pipes, and this increases the chance of water contamination with chemical compounds present in the soil, in addition to water pollution with biological indicators (coliform) [10]. In addition to what was mentioned above, the length of the pipe network means an increase in the surface area for bacterial growth in the pipes, which leads to a decrease in pH (which contributes to the corrosion of pipes) and also contributes to a decrease in the level of calcium [11]. The move of heavy vehicles and built the huge number of building will increase the chance of broken the pipes especially in the areas far from the water distribution station. The most important of which is that the remote areas are adjacent to the agricultural areas in which pesticides and chemical fertilizers are used that explain increase in the level of nitrate. Moreover, the level of sewage water may effect on the level of nitrate. The nature of the clay soil of Al-Sadr City plays an important role in the occurrence of fracture in the pipeline network, as this type of soil is characterized by its slippage when exposed to pressure on (this is due to the vehicles and the dense construction in this area).

Despite the water quality was within the standard specifications, but it was in critical levels, and this means the need to reconsider the water distribution network, as the contamination of drinking water will have a significant impact on the percentage of diseases in this region, which suffers mainly from the poor health system.

From what was mentioned above, the current study concluded that water quality depends largely on the length of the water distribution network and the quality of the water from which the liquefied water is taken.

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### نوعية مياه الشرب في مدينة الصدر في مدينة بغداد

□ حميدة كاظم زغير

مديرية تربية الرصافة الثالثة، وزارة التربية، بغداد، العراق

مستخلص البحث:

تلعب جودة مياه الشرب المقدمة للأسر دوراً مهماً في الصحة العامة. يلعب طول شبكات توزيع المياه وجودتها دوراً مهماً في جودة المياه. الدراسات التي تسلط الضوء على جودة مياه الشرب التي يتم توفيرها للأكثر كثافة سكانية في بغداد (مدينة الصدر)، وكذلك العلاقة بين طول شبكة توزيع مياه الشرب ونوعية المياه، شحيحة في الأدبيات. الدراسة الحالية تغطي هذه الفجوة. في الدراسة الحالية تم جمع 170 عينة من مياه الشرب من 17 منطقة مختلفة من مدينة الصدر (شرق القناة)، بغداد، العراق والتي تقع على مسافات مختلفة من محطة توزيع مياه الشرب. تم قياس الأس الهيدروجيني والصلابة الكلية وتركيزات الكلوريد والنترت والكبريتات والكبريتات والكالسيوم والمغنيسيوم والحديد والرصاص والفوسفات. كما تمت دراسة إثبات التلوث المايكروبي بإجراء الاختبارات البكتريولوجية (الكشف عن بكتريا القولون البرازية). أظهرت النتائج أنه تم عزل خمس عزلات من بكتريا القولون غير البرازية من العينات التي تم جمعها من المناطق الأبعد عن محطة التوزيع. وأظهرت النتائج أن مواصفات مياه الشرب المأخوذة كانت ضمن المواصفات القياسية. كما أظهرت النتائج بوضوح تأثير طول شبكة التوزيع على جودة المياه. علاقة سالبة ( $P > 0.05$ ) بين مسافة محطة التوزيع (DDS) لقيم الأس الهيدروجيني والمياه والصلابة الكلية وتركيزات الكلوريد والفوسفات. كما أظهرت النتائج وجود علاقة موجبة بين DDS وتركيزات النترت والكبريتات والمغنيسيوم والحديد. لا توجد علاقة بين DDS وتركيزات النترات والكبريتات والرصاص. يمكن الاستنتاج من الدراسة الحالية أن طول شبكة توزيع المياه له دور كبير في تغيير مواصفات جودة مياه الشرب الموزعة على المنازل.

الكلمات المفتاحية: بكتريا القولون البرازية، مسافة محطة التوزيع، الصحة العامة، جودة المياه، مدينة الصدر.