

ARTICLE / INVESTIGACIÓN

Study the quality of drinking water in the holy city of Karbala

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Abstract: This study aims to assess the quality of drinking water in Karbala. Furthermore, the quality of tap and bottled water are compared in this study. Materials and method: Physical, chemical, and bacteriological parameters were all measured in the study. The bacteriological test includes a total count of coliform and fecal coliform, which may be detected using standard microbiology procedures. Results: In bottled water, total dissolved salts (TDS), Ca, Cl, and Mg were within acceptable ranges, like that in tap water, the mentioned parameters were within normal ranges except for regions Aborwayah, Al-wend, Al-khayrat and Al-husainia which were beyond the expected value. In terms of bacteriological tests, coliform bacteria were found in bottled water (Al-katara water and Al kafeel) samples with no *E. coli* bacteria. In the case of tap water samples, the findings revealed that most of the regions (9 out of 12 = 75%) had coliform bacteria growth, so (4 out of 9 = 44. 4%) had *E. coli* bacterium growth does not comply with the approved standards for drinking water, which must be free of the microbial content of *E. coli* and coliform. Conclusion: According to the study, drinking water treatment operations are not up to par, particularly in locations outside of the city center, and bottled water is preferable to tap water for drinking.

Key words: Drink water, coliform, TDS, Chloride, turbidity.

Introduction

Water is a significant natural resource globally, and sustaining human life is the essential thing on earth¹. The physicochemical characteristics of water are often a crucial factor in determining and assessing the quality of drinking water. Various chemical and physical criteria may be used in the evaluation of water quality. Several guidelines were formulated to individually test the chemical and physical parameters of the quality of drinking water (World Health Organization, 2004². Transmitted by disease-causing microbes via drinking water is primarily of fecal origin, and they are recognized as enteric pathogens^{3,4}. The World Health Organization (WHO) criteria indicate that no drinking water should contain any microorganism considered to be pathogenic or some other microorganism fecal pollution-indicative bacteria⁵.

Approximately 250 thousand people die every day worldwide due to diseases (typhoid, cholera, etc.) caused by unsafe water use, according to WHO (2006) evidence. Problems with water supplies have been one of the most critical concerns throughout human life⁶. As a result of poor treatment and disposal of waste, industrial discharge and overuse of limited water resources, pollutants such as bacteria, viruses, heavy metals, nitrates and salt have made their way into water supplies⁶. Working in close cooperation with the Government of Iraq for many years, WHO and UNICEF have been profoundly concerned about this situation. They are keen to provide assistance to improve the health status of the general population and minimize morbidity and mortality through activities aimed at protecting and promoting the quality and protection of the supply of water². To ensure that water supplied to customers is well regulated

and follows national standards and WHO guidelines on drinking water quality, an expanded network of water quality control laboratories has been established. The study aims to analyze and compare the quality of drinking water in the areas studied in Karbala city.

Materials and methods

Sample Collection

Eighteen water samples were collected from different places in Karbala governorate from November 2020 up to September 2021, where six samples of bottled water distributed the samples and twelve samples of tap water, and regions numbered from 1 to 18 as in table (1).

The samples were collected in germ-free plastic bottles, taken to the laboratory and analyzed directly.

Chemical analysis

A turbid meter device HACH 2001N was used to measure the turbidity of the water. In addition, total dissolved salts (TDS) were estimated using the inolab-cond 7110 devices and the pH of the water using a pH meter. The chloride, magnesium, and calcium concentrations were determined using the titration method.

Bacteriological analysis

Many culture media were used for isolation of bacteria such as nutrient agar (Oxoid) for total aerobic bacterial count, MacConkey agar (Himedia) for coliform count and

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No.	Region name	Type of water
1	Al-kawther	Bottled water
2	Al- harameen	Bottled water
3	Salsabeel	Bottled water
4	Al-Katara	Bottled water
5	Al-kafeel	Bottled water
6	Al-wareth	Bottled water
7	Al-Khadeer	Tap water
8	Al-mowathafeen	Tap water
9	West of Al-abaseia	Tap water
10	Al-seglah	Tap water
11	Aborwayah	Tap water
12	Eshan	Tap water
13	Al-wafaa	Tap water
14	Al-wend	Tap water
15	Karbala	Tap water
16	Al-khayrat	Tap water
17	Al-husainia	Tap water
18	Al-Imel qqrter	Tap water

Table 1. Numbering of regions involved in the study.

brain-heart infusion agar (Himedia) for fecal streptococci count. These media were sterilized in an autoclave at 121 C° for fifteen minutes. Samples were appear growth at tubes of multiple fermentation tube technique cultured on the prepared medium in duplicate and incubated aerobically at 37 C° for TBC and TC. The colonies were counted and expressed as colony-forming unit's per100 milliliter (CFU/100ml) of the samples as described by APHA (1998). The presence of these bacteria was expressed in the results table with the presence or absence (+/-). Various biochemical tests were carried out for bacterial identification; in addition, the diagnosis of *E. coli* was confirmed by the VITEK-2 technique.

Results and discussion

The chemical analysis results of some biochemical parameters of drinking water (Table 2) show normal ranges for all parameters with the mean values. A high turbidity value appeared in Al-kawther region (4.9) and a lower reading at Al-kafeel region (2); these results reach the acceptance of Iraqi limits specification (417)⁷ and the WHO guidelines for drinking-water quality². also, the results have come in contact with other Iraqi researches^{1,6,8} in Baghdad, Erbil and Hilla respectively. TDS shows a common mean value and recordings in all regions with a high record at (247) and low at Al-Katara (38), also, the result was acceptable in Iraqi limits specification and WHO^{2,7} and (1,6,8). The normal pH range for drinking water is between 6.5 – 8.5; the measurement of pH was normal in all regions except for the region that appeared highly alkaline with a pH 8.5 in salsabeel sample,

and the lower pH was in Al-Katara (6.6) which appeared near to results of researches in Baghdad, Erbil, Diwanyia and Al-Kut^{1,3,4,8}. Chloride (Cl) is added as a disinfectant to water which leads to the formation of acids⁹; the purpose is to kill pathogens causing disease, such as bacteria, viruses, and protozoans, that commonly grow in water supply reservoirs¹⁰, with a high level in salsabeel (71 mg/l) and the lower level was in Al-Katara (14 mg/l), all of these are within normal level according to Iraqi limits specification (417)⁷ and the WHO guidelines for drinking-water quality², and agree with many studies^{1,6,8} in Iraq. Ca++ and Mg ions are also within acceptable and safe levels; the results were agreed with other studies in Iraq, Baghdad^{8,11,12}, Erbil^{1,13}.

Table (3) shows the presence of bacterial contamination in drinking water. Only two regions (Al-Katara and Al-kafeel) found bacterial coliform contamination over the zero average counts, and all samples were negative for *E. coli*. These results found agreement with other Iraqi studies⁸ in Baghdad, Mosul¹⁴ and Hilla⁶.

The study also investigated the tap water for chemical constituent and bacterial contamination, as shown in tables (4 and 5) in which there was a high variation in chemicals level and coliform bacteria contamination with or without the presence of *E. coli*. The turbidity index shows a standard value except in region 1 (5), and the results disagreed with a study in Baghdad that found that some regions were above (60)¹⁵. All regions were at the threshold of TDS, and three of them were above (1000), which appear near the same study results in Baghdad. The primary sources of high TDS in river water may result from agricultural runoff, soil erosion, house waste, and other human activities¹⁸. The other parameters

Regions No.	Turbidity	TDS mg/L	pH	Cl mg/L	Mg mg/L	Ca ⁺⁺ mg/L
1	3.6	216	7.4	63	20	2
2	3.1	247	8.5	71	16	5
3	3.9	38	6.6	14	4	2
4	2	214	7.8	49	12	5
5	3	175	8	28	6.4	8
6	4.9	102	7.1	35	8	5
Norma value	Up to 5	33-524 mg/L	6.5-8.5	Up to 250 mg/L	Up to 75 mg/L	Up to 100 mg/L

* TDS: Total Dissolved Solids

Table 2. Results of chemical analysis of bottled drinking water (RO) samples in different Karbala regions

Regions No.	Coliform cfu/100ml	<i>E. coli</i> cfu/100ml
1	-	-
2	-	-
3	-	-
4	+	-
5	+	-
6	-	-

Table 3. Results of bacteriological investigation of drinking water samples in different Karbala regions.

* (+) contain coliform bacteria over normal count.

Regions No.	Turbidity	TDS mg/L	pH	Cl mg/L	Mg mg/L	Ca ⁺⁺ mg/L
7	5	914	8.5	95	100	24
8	4.5	954	8	113	80	46
9	4.8	937	8.5	96	80	29
10	3.2	940	8.4	120	64	40
11	3	1051	8.3	106	120	29
12	4.7	958	8.3	106	72	28
13	4	865	8	127	88	34
14	4.5	1048	8	120	80	34
15	2.5	925	8.1	127	72	33
16	5	1088	8.4	149	96	38
17	4	1017	8.1	114	132	21
18	3.4	909	8.5	127	96	34
Normal value	Up to 5	Up to 1000 mg/L	6.5-8.5	Up to 350 mg/L	Up to 100 mg/L	Up to 150 mg/L

Table 4. Results of chemical analysis of tap water samples in different Karbala regions.

show an undulation between normality and abnormality; the pH was within normal standardized but tended to alkalinity with a mean value (8.3). The calcium also appeared normal in all regions, Mg was above stander measurement in three regions (7, 11 and 17), and the Ca⁺⁺ showed normality. These parameters converge with that study in Baghdad¹⁵.

The bacterial analysis of tap water shows a diversity of contamination with coliform bacteria in several regions, and only three regions (7, 15 and 18) give negative culturing of coliform bacteria. This indicates poor water sanitation in Karbala in general; these results also agree with other Iraq

studies (6, 8, 14, 16 and (17). At the same time, *E. coli* culturing on EMB media shows a negative in all regions except (11, 14, 16 and 17), a positive culture for *E. coli* isolation from these regions as in table (5). Coliform bacteria are sources of human and animal excreta pollution in water. Fecally contaminated water contains harmful pathogens, and so it is not safe in use by human daily works¹⁹. Also, the high bacterial count was due to old piped city projects or inefficient filtration and precipitation process²⁰, the chlorination time during sterilization was not enough²¹.

The existence of these organisms in some of the drin-

Regions No.	Coliform	<i>E. coli</i>
7	-	-
8	+	-
9	+	-
10	+	-
11	+	+
12	+	-
13	+	-
14	+	+
15	-	-
16	+	+
17	+	+
18	-	-

* (+)contain coliform bacteria up to average count.

Table 5. Results of bacteriological investigation of tap water samples in different Karbala regions.

king water samples under investigation is significant in terms of public health. It's possible that this is due to poor sanitation in the neighborhood. Drainage and floods of contaminated surface water into water sources could also be causes. These organisms could also be due to the openness of water sources, which allows particles from the environment to enter quickly, or contaminated equipment to draw water from the sources. Also, the factor of distance from the city affects the high rate of contamination due to the lack of residual chloride or its absence, which leads to the presence of these harmful bacteria in drinking water in remote areas humble point of view.

Not to mention that most rural residents dump their homes' sewage into the mouths of rivers, which are the source of water pumping stations for the filtration and treatment units for drinking water? This investigation revealed that bacterial contamination in drinking water samples from most regions of Karbala, especially those furthest from the city center, exceeds the legal limit, implying that the processes employed to filter and sterilize drinking water are not up to par. Not to mention that most individuals in rural areas dump their sewage into rivers, which serve as a supply of water for water pumping stations and filtration and treatment units for drinking water.

Conclusions

The study suggests working to develop drinking water distribution networks following international standards and using alternatives to chlorine sterilization and strict government oversight to provide safe, healthy water to residents of the governorate in all of its regions without discrimination. The current study showed that there is bacterial contamination that exceeds the permissible limit in drinking water samples for most areas of Karbala, especially areas far from the city center, as well as bottled water, and this gives the impression that the procedures used to filter and sterili-

ze drinking water are not at the required level.

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Authors' Contributions

All authors listed have made a substantial, direct and intellectual contribution to the work and approved it for publication.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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None.

Data Availability

All datasets obtained or studied during this study are incorporated in the manuscript.

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