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

Salim Hussein Hassan*, Jaafar Khalaf Ali

Department of Community Health, Karbala Technical Institute, Al-Furat Al-Awsat Technical University, Iraq.
Corresponding author: inkr.salim@atu.edu.iq

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 Abowayah, 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 earthﬂ. The physicochemical characteristics of water are often a crucial factor in determining and asessing 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, 2004ﬃ. Transmitted by disease-causing microbes via drinking water is primarily of fecal origin, and they are recognized as enteric pathogensﬄ. 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 bacteria﬇. Approximately 250 thousand people die every day worldwide due to diseases (typhoid, cholera, etc.) caused by unsafe water usage, according to WHO (2006) evidence. Problems with water supplies have been one of the most critical concerns throughout human life﬈. 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 supplies﬉. 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 waterﬁ. 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 sex 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...
4. 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 per 100 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-Katara region (2); these results reach the acceptance of Iraqi limits specification (417) and the WHO guidelines for drinking-water quality. Also, the results have come in contact with other Iraqi researches in Baghdad, Erbil, and Al-Kut. Chloride (Cl) is added as a disinfectant to water which leads to the formation of acids; the purpose is to kill pathogens causing disease, such as bacteria, viruses, and protozoons, that commonly grow in water supply reservoirs; 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) and the WHO guidelines for drinking-water quality.

Table 1. Numbering of regions involved in the study.

| 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-Khadere     | Tap water     |
| 8   | Al-mowathafoen | Tap water     |
| 9   | West of Al-abaseia | Tap water |
| 10  | Al-seghah      | 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-Inal quarter | Tap water    |

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 studies in Baghdad, Mosul, and Hilla. 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). 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 activities. The other parameters
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 Baghdad.

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 works. Also, the high bacterial count was due to old piped city projects or inefficient filtration and precipitation process, the chlorination time during sterilization was not enough.

The existence of these organisms in some of the drin-

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

| 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         |

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

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

* (+) contain coliform bacteria over normal count.

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

| 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
The impression that the procedures used to filter and sterilize drinking water samples in different Karbala regions from the city center, as well as bottled water, and this gives samples for most areas of Karbala, especially areas far 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 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 the mouths of rivers, which serve as a source 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 sterilize drinking water are not at the required level.

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Authors’ Contributions

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Conflicts of Interest

The authors declare that there is no conflict of interest.

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Data Availability

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

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