

Chemical and microbiological properties of drinking water in the city of Baghdad

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Abstract

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Background: The quality of drinking water is directly related to community health. Therefore, improving the quality of drinking reflects positively on the health situation in general. The studies that deal with the quality of drinking water in the city of Baghdad in terms of chemical or microbial content are very scanty.

Objective: The current review highlights the most important studies and research articles that concern the quality of drinking water, both bottled water and tap water, in terms of chemical and biological contamination and chemophysical specifications for drinking water.

Abstract: Studies have shown that drinking water in the city of Baghdad, especially tap water, contains certain levels of heavy metals, and some bacterial species have also been diagnosed in drinking water transmitted through taps. But the levels of most of them are within the international standards. Although there are some indications of chemical and biological contamination.

Conclusion: Although the standard specifications for drinking water in the city of Baghdad are acceptable, the pollution indicators in both tap water and bottled water should be monitored seasonally.

Keywords: Baghdad city, Bacterial isolates, Chemical content, Drinking water, Tap water

Introduction

Drinking water distributed to homes is directly related to human and animal health [1]. This is confirmed by international reports, as most studies related to public health focus on the quality of drinking water [1]. Whenever the chemical and biological content are within the normal levels and in line with the levels determined by the reports issued periodically by the World Health Organization and other organizations concerned with public health, the health

status of the country will be good, because the pollution of drinking water has a strong link with the outbreak of infectious and noninfectious diseases [2].

Microbial contamination is associated directly with outbreaks of infectious diseases and is the main factor of causing epidemics and pandemic infectious diseases, such as cholera, typhoid, sessional diarrhea and some fungal infections of the skin [3][4]. The treatment and purification of water from

microbial contamination may be easier compared to the treatment of water from chemical pollution, in addition to the cost of treating and purifying water from microbial contamination may be less than purifying water from chemical pollution [5]. There are many methods used traditionally to purify water from microbial content; the easiest and cheapest is heating and filtering water [4].

The possibilities of purifying water from microbial content are available in Iraq by exposing the water to chlorine gas. Despite the ease of treating water from microbial contaminants, it is considered a biohazard material because they are characterized by their ability to multiply and self-replicate in water [4]. Chemical pollution is one of the major problems that third world countries suffer from, especially Iraq [6]. This lies in the difficulty and high cost of the methods used to purify water from chemical content, especially from heavy metals [7]. The source of pollution in Iraq, especially in Baghdad, is the presence of some factories close to water sources and not subject to sanitary control [8]. The diseases associated with chemical pollution are dangerous diseases due to the effect of many chemicals on the nervous system, as well as the concentration of these substances in the food chain, which can end up in humans and which can cause dangerous cancerous diseases [9].

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]. 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 current article aims to shed light on the level of microbial and chemical pollution in drinking water in the city of Baghdad, the extent of its impact on human health, and the methods used to address this problem.

Quality of Tigris water

There are many studies that highlight the water quality of the Tigris River, especially in the city of Baghdad. These studies are important because the main source of drinking water and tap water comes from water purification plants that take water from the Tigris River. Therefore, the quality of the water of the Tigris River will effect on the quality of drinking water in the taps if the water isn't treated properly [11][12][13][14]. Al-Janabi *et al* (2012) used the application of Canadian Council of Ministers for the Environment Water Quality Index (CCME WQI) for the 3 stations located along with Tigris River in Baghdad city, Iraq. They used eleven water quality parameters (pH value, Total Dissolved Solids, Calcium, Total Alkalinity, Ammonia, Nitrate, Nitrite, Turbidity, Lead Chromium, Iron). According to the results obtained from their study, the investigators proved that the water quality of Tigris River was worst quality due to the effect of various urban pollutant sources [13]. Abed *et al.* (2019) implemented multivariate statistical techniques and multiple linear regression analysis (MLRA) to evaluate important parameters affecting water quality during the year 2017-2018. The study included 25 water quality. The researchers described that the water quality (some parameters) in the Tigris River changes

depending on the season; that is why, it needs high purification in order to reach good levels [14].

Tap water and bottle water in Baghdad city

Since April 2003, in the city of Baghdad, the use of bottled water (different size) has spread widely in the market due to the high percentage of contamination in tap water, as it was clear that this was determined by specialists and non-specialists through the change in the color and taste of the water that comes through the taps [15]. This generated uncertainty about the quality of tap water after the war and is reflected in the rise in water treatment centers in the city of Baghdad [15]. The problem with that is that these stores are not subject to health supervision and are not approved by the Ministry of Health [11]. Despite this, the citizens' satisfaction survey showed the use of bottled water, according to the statistics of the competent authorities. The results of the field survey in Baghdad showed that citizens avoid drinking tap water for fear of contamination. This is due to the lack of serious follow-up to the treatment of stored water and the storage mechanism in stores in addition to the lack of health approvals to open these stores and laboratories responsible for purifying and filling water in these bottles; thus, treatment usually depends on the individual's experience, as a result of the lack of standards. The problems linkage with the tap water supplies by the pipes can be categorized into three major factors: First, the quality of the water taken from the Tigris River. Secondly, the treatment process to which water is subjected to drinking water treatment plants, and two-thirds of the

network distribution system, which is subject to rushing due to the old network, lack of maintenance and misuse [10].

Bacteriological contamination in tap water of Baghdad city

The current review highlighting the bacterial contamination of drinking water supplied to the city of Baghdad, because studies dealing with viral and fungal contamination were not addressed in previous researches articles.

One of the most important indicators of contamination of drinking water with high risk pathogens is the presence of coliform bacteria [16]. The bacteriological analysis of drinking water focuses on the total numbers of live bacterial counts in the water and on the total number of coliform bacteria and fecal coliform bacteria in addition to the total number of *Pseudomonas aeruginosa*. The previous study showed the presence of several bacterial species of Enterobacteriaceae in drinking water of Baghdad city. *Escherichia coli* and *P. aeruginosa* were the most common. The presence of these two types of bacteria in drinking water likely indicates contamination of this water with human and animal feces, and this could strengthen the hypothesis of the presence of pathogenic microbial factors that can be transmitted through human or animal feces [11]. The bacterial content in the drinking water distributed to the city of Baghdad varies according to the seasons of the year. The highest incidence of bacterial contamination with *E. coli* in the spring and summer seasons is higher than winter and autumn seasons; this could be due to the effect of temperature and nutrient content on doubling the number of bacteria in the water,

which varies according to the seasons of the year [17].

Previous studies showed that contamination of drinking water with fecal *E. coli* in warm seasons is higher than in cold seasons. Similar finding was reported in the case of investigation of total coliform, total viable bacterial count and *P. aeruginosa* counts. Similar studies reported that different bacterial species were isolated from the water treatment stations of Baghdad city (*P. fluorescens*, and *Klebsiella pneumonia*) [11][17].

The results that obtained by previous study showed that the presence of coliform in drinking resource water may be due to un control and non-monitoring activity of some food factors and hospital that through their biological wastes in water without treatment [16]. AL-Dulaimi and Younes, (2017) they confirmed the presence of various types of coliform bacteria especially *E. coli* in drinking water (tap water) that is distributed to different neighborhoods of the city of Baghdad. The presence of fecal contamination indicators in drinking water or water purification sources seriously indicates the seriousness of the health situation in the city. This requires serious work to conduct periodic checks to monitor microbial contamination of drinking water, through which it is possible to determine the effectiveness of drinking water treatment plants that are distributed to homes [11].

Physiochemical property of tap water of Baghdad city: Many factors affect the quality of drinking water, including the water source, the treatment process, the method of water storage, the nature of the water distribution network, and its compliance with health

specifications set by international organizations concerned with the quality of drinking water [18]. The previous studies showed that the pH of the water is one of the most important indicators of the quality of drinking water. Previous studies showed that tap water in Baghdad city is alkaline. The studies showed that there were no significant differences in the quality of water samples taken from different locations as compared with international standards [11][18]. Previous studies showed that the electrical conductivity (EC) and total dissolved solids (TDS) concentrations of tap water of Baghdad city drinking water were in line with international standards of WHO [19]. TDS level considerably different among regions because the mineral solubility differences and local environments. The TDS concentrations in the city of Baghdad are within acceptable levels (< 1000 ppm) [11]. The varieties of EC and TDS levels between Baghdad districts are due to differences in tap water sources and treatment techniques. Another study investigated the physiochemical properties of drinking water sampled from different places. The obtained results were compared with the international and national standards and it was shown that they are within the permissible limit of the standards published by the reports of the WHO, except for the EC values of different samples, which were higher than the allowable level. This confirms the need to continuously monitor all water quality indicators, as this will reflect on the health of the residents of the city of Baghdad [19][20].

Heavy metal in drinking tap water

The studies that dealt with the estimation of the level of heavy metals in drinking water in

Baghdad are scanty. The study carried out by Alrakabi, and Ramadan (2017) highlighted the level of manganese, iron, cobalt, nickel, copper, zinc, arsenic, cadmium and lead in drinking water (tap water), of different places of city of Baghdad. They found that the mean levels of Mn, Fe, Pb, Ni, and Cd were higher than the permissible limit, while the levels of Cu and Zn were less than the standard levels that were reported by the WHO [20].

Bottled water quality

The steady increase in the consumption of bottled water is due to the consumer's conviction that the quality of bottled water is better than that of tap water [21]. The results of some previous studies showed that bottled drinking water is moderately alkaline with a pH higher than 8. Furthermore, the TDS levels in the tested bottled water samples were moderately high. This is due to the fact that this water has not been treated properly by special osmotic technology or that this water comes from mineral sources. Therefore, sulfate levels are moderately high in the tested bottled water. Thus, the water should be treated with carbonate components to improve the quality of bottled water. Though, bottle drinking water is assumed to increase the erosion of tooth enamel [22]. Most laboratory investigations on bottled water confirmed that the quality of water is in line with slandered limitations of the WHO [11].

Comparison of tap water vs bottled water: Several studies have focused on making a comparison between the quality of bottled water and drinking water that is distributed through taps in many laboratories [21]. Studies have shown that despite of bottled water is more expensive than tap

water, this does not necessarily mean that the quality of bottled water is better than drinking tap water [23][24][25]. Sometime the quality of tap water has a better quality because more stringent and frequent control procedures was followed to produce a good tap water quality. Bottled water generally has a higher pH than tap water. Through the articles that were reviewed, we recommend that drinking water and bottled water should be monitored and analyzed to ensure that the microbial and chemical content is within the permissible levels. Moreover, we recommend strongly to determine the radioactive content, because Iraq has been exposed to many wars in which various types of weapons were used, in addition to the weak control over environmental pollution in Iraq, and moreover, because of the weak rule of law, many chemical and biological factories, in addition to hospitals (government and the private) release their biological and chemical waste into the main resource of waters in Baghdad city.

Conclusions

The current review showed that the levels of microbial and chemical content in addition to the chemophysical properties of both types of drinking water distributed through pipes or through water bottles were in general normal, but as a result of changing water specifications depending on the seasons, so it is necessary to follow up the properties and quality of drinking water in each season and periodically.

Recommendations

The present study suggests that pollution indicators in both tap water and bottled water should be monitored seasonally.

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Conflict of interest: Nil

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الخواص الكيميائية والميكروبيولوجية لمياه الشرب في مدينة بغداد

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الملخص

خلفية الدراسة: ان نوعية مياه الشرب ترتبط ارتباطا مباشرا مع الصحة المجتمعية. ولهذا فان تحسين جودة الشرب سوف ينعكس وبشكل ايجابي على الواقع الصحي بصورة عامة. ان الدراسات التي تتناول جودة مياه الشرب في مدينة بغداد من حيث المحتوى الكيميائي او المايكروبي قليلة جدا.

اهداف الدراسة: ان نوعية مياه الشرب ترتبط ارتباطا مباشرا مع الصحة المجتمعية. ولهذا فان تحسين جودة الشرب سوف ينعكس وبشكل ايجابي على الواقع الصحي بصورة عامة. ان الدراسات التي تتناول جودة مياه الشرب في مدينة بغداد من حيث المحتوى الكيميائي او المايكروبي قليلة جدا.

الخلاصة: بينت الدراسات بان مياه الشرب في مدينة بغداد وخاصة مياه الصنابير تحتوي على مستويات معينة من المعادن الثقيلة وكذلك تم تشخيص بعض الأنواع البكتيرية في مياه الشرب التي تنتقل عبر الصنابير. ولكن مستويات معظمها تقع ضمن المستوى القياسي الدولي. رغم وجود بعض مؤشرات التلوث الكيماوي والبايولوجي. لذا واستنادا لما ذكر اعلاه فاننا نوصي بضرورة ان يتم متابعة مستوى التلوث في مياه الصنابير ومياه القناني على حدا سواء.

الاستنتاجات: على الرغم من أن المواصفات القياسية لمياه الشرب في مدينة بغداد مقبولة ، إلا أنه يجب رصد مؤشرات التلوث في كل من مياه الصنبور والمياه المعبأة موسميا.

الكلمات المفتاحية: مدينة بغداد، العزلات البكتيرية، المحتوى الكيميائي، مياه الشرب، ماء الصنبور

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