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The Evaluation of Residual Chlorine from Well Drinking Water in Some Quarters in Erbil City-North Iraq

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Abstract

The study was conducted in Erbil city north of Iraq. Everywhere in the world, the drinking water utilities face the challenge of providing water of good quality to their consumers as significant water quality changes can occur within drinking water distribution systems due to contamination. From this study, we have collected water samples from twenty well drinking water in some quarters from Erbil City with three replicas. Our results showed that the maximum value of free chlorine recorded in Badawa and Galawesh quarters which were greater than 0.5 mg/l, while, the values of free chlorine of most quarters were less than 0.2 mg/l, which were not within the recommended safe residual chlorine level of 0.2–0.5mg/l.

Keywords: Free Chlorine, Water Consumer, Drinking Water, Water Well, Erbil

1. Introduction

Across the globe, drinking water services face the challenge of providing good quality water to their consumers as significant changes in water quality can occur in drinking water systems due to contamination. A disinfectant such as chlorine can control the growth of pathogens but it reacts with the organic and inorganic matter in water, the concentration of chlorine decreases with time, called chlorine decomposition [1].

Chlorine is a strong oxidant, it reacts with a wide range of chemicals and organic (and / or inorganic) materials naturally present in treated water and / or distributed to form potentially harmful disinfection by-products (DBP): Some of these DBPs are suspected of being carcinogenic and have adverse effects on reproductive and developmental health [2]. Any water authority needs to manage chlorine disinfection in the lower and upper limits of residual chlorine to simultaneously protect consumers from waterborne diseases and harmful DBP. For example, residual chlorine concentration at various points in the drinking water distribution system may be considered as the last control of water quality provided to consumers. Due to the importance of disinfection, several investigators have researched to develop models to predict the decomposition of chlorine in drinking water [3].

It is easy to believe that the safety of modern drinking water treatment systems is secure, but before widespread filtration and chlorination, contaminated drinking water posed a significant risk to public health. Water-based microscopic agents such as cholera, typhoid fever, dysentery, and hepatitis A have killed thousands of US residents each year before chlorine disinfection methods are increasingly used in Jersey. City, New Jersey [4].Worldwide, at least 2 billion people use chronic diarrhea, cholesterol, dysentery, typhoid, hay fever, and polio [5]. Contaminated drinking water is estimated

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to cause more than 500,000 deaths each year, mostly among children. [6], Although developed countries have largely eliminated waterborne pathogenic bacteria through the use of chlorine and other disinfectants, the developing world is still struggling with these public health enemies [5].

Contamination of water resources by pathogens Chlorine is lost by reaction with substances left in the water after treatment, especially organic and inorganic substances such as iron, manganese, or ammonia. Chlorine degradation, therefore, depends on the residence time [7]. Chlorine infection, however, shows problems such as the production of trihalomethane (THM) from its reaction with Natural Organic Matter (NOM) in water [8]. The mechanisms and rates of decomposition of hypochlorous acid (HOCl) and hypochlorite ion (OCl) depend on many factors including pH, chemical concentration, solar radiation (UV), and temperature [9] In addition to decomposing free chlorine, UV radiation from solar radiation can also act as a strong disinfectant in removing pathogenic organisms from water because it destroys germs, viruses and other pathogens by inactivating their DNA [10]The main aim of this study is to evaluate residual chlorine in drinking water in Erbil City and to compare recommended chlorine levels (WHO).

2. Material and Method

The study was conducted in Erbil city north of Iraq which covers about 18170 square kilometers (Fig.1). It is bounded by greater Zap River from the North-West and by little zaps River from the South-East of Iraq. Boundaries extended from longitude 43 15 E to 45 14 E and from latitude 35 27 N to 37 24 N [11].

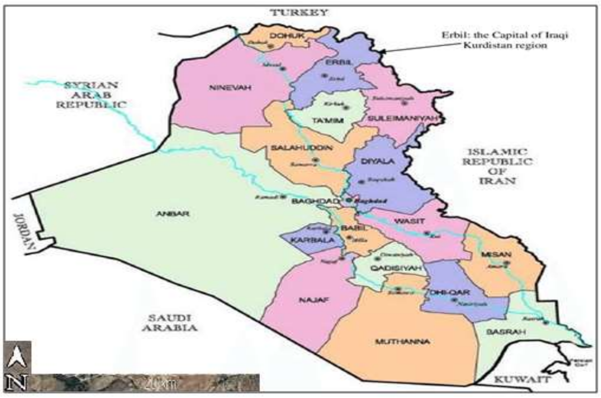

Figure 1. Location of the studied area (Iraq map) [11]

2.1. Sample Collection

Water samples were taken from twenty wells in some quarters in Erbil city (Azadi, Zhyan, Topzawa, Ankawa, Harsham City, Runakey, Daratw, Rasty, Havalan, 32 Park, Farmanba-ran, Kurany-Ankawa, Andazyaran-city, Zanko, Galagay rash, Hawley-New, Shady, Mahabad, Badawi and Galawesh) with three replicas. Then, we analyzed free chlorine using (Pool tester, Germany) as shown in the (Fig.2). Then we compared our results with the recommended safe residual chlorine level of 0.2–0.5 mg/l [12].

Figure 2. Pool water test kits

2.2. Statistical analysis

Statistical analysis was performed using a software program (SPSS version 18). All data were treated with the one-way ANOVA (Analysis of Variance), Post hoc test (Duncan) for detecting a significant difference between variables at different sites. All data are expressed as mean ± S.E.

3. Results and Discussion:

Chlorine is such a strong oxidizer, it reacts with a wide range of chemicals and naturally occurring organic (and/or inorganic) matter (NOM) in the treated and/or distributed water to form potentially harmful disinfection by-products (DBPs). Some of these DBPs are suspected carcinogens and having adverse reproductive and developmental health effects [2] The free chlorine values of the studied sites ranged from 0.1 to 1.07 (mg/l) between sites as shown in (Figure 3 and Table 1). The minimum value of free chlorine recorded in 32 Park, Bnaslawa, Andazyaran –city, Ankawa, Daratw, Harsham-City, Havalan, Hawlery-New, Kurany, Ankawa, Mahabad, Rasty, Shady, Topzawa which were not within The recommended safe residual chlorine level of 0.2–0.5 mg/l [12] is therefore not easily maintained in the distribution network and therefore increasing recontamination risk, also which may be related to water well operator to not add enough chlorine and not use scientifically method to treat with the chlorination process. Factors such as dissolved organic carbon, Fe^{2+}, Mn^{2+}, NO^{2-},H_2S, H_2SO_3, ammonia, high temperatures and also corroded pipes, dead ends, long storage time [14] that can be attributed to low chlorine levels at the reservoirs and further depletions during conveyance in the very old pipes in the network. Several factors, however, influence chlorine decay in water distribution network [15]

Where other, the maximum value recorded in (Galawesh and Badawa) as shown in (Figure 3 and Table 1) which were greater than 0.5 not within the recommended safe residual chlorine level of 0.2–0.5 mg/l [12]. Chlorine disinfection, however, shows problems such as the production of trihalomethane (THM) from its reaction with natural organic matter (NOM) in water [2]. The mechanisms and rates of decomposition of hypochlorous acid (HOCl) and hypochlorite ion (OCl) are dependent on many factors including pH, chemical concentration, solar radiation (UV), and temperature [9]. Zanko, Runakey, Azadi, Farmanba-ran and Zhyan) (Figure 3 and Table 1), which were within the recommended safe residual chlorine level of 0.2–0.5 mg/l [12], this ensures microbiologically safe water.

Statistically, there were no significant differences ($p<0.05$) between (Azadi,Topzawa , Ankawa, Harsham-City, Daratw, Rasty, Havalan, (32 parks), Farmanba-ran, Kurany-Ankawa, Andazyaran –city, Zanko, Bnaslawa, Hawlery-New, Shady and Mahabad) quarters (Table 1). While, (Badawa and Galawesh) quarters were significant differences ($p<0.05$) in compared to other sites (Table 1), which were greater than 0.5 not within the recommended safe residual chlorine level of 0.2–0.5 mg/l [12], which may be related to water well operator to use more chlorine and not use scientifically method to treat with the chlorination process, and not a good concern from the Government.

Table 1. Mean ± SE for parameters (according to the site of sampling) with minimum and maximum values**.**

Quarters	Free chlorine
Azadi	cb . 30±0.05 0.54-0.05
Zhyan	b. 0.46± 0.08 0.84-0.08
Topzawa	c . 0.10±0.00 0.10-0.10
Ankawa	c . 0.10±0.00 0.10-0.10
Harsham city	c . 0.10±0.00 0.10-0.10
Runaky	b 0.33±0.12 0.85-0.18
Daratw	c . 0.10±0.00 0.10-0.10
Rasty	c . 0.10±0.00 0.10-0.10
Havalan	c . 0.10±0.00 0.10-0.10
32 Park	c . 0.10±0.00 0.10-0.10
Farmanbaran	cb . 30±0.05 0.54-0.05
Kurany anknawa	c . 0.10±0.00 0.10-0.10
Andazyaran city	c . 0.10±0.00 0.10-0.10
Zanko	cb . 26±0.03 0.41-0.12
Bnaslawa	c . 0.10±0.00 0.10-0.10
Hawlery- new	c . 0.10±0.00 0.10-0.10
Shady	c . 0.10±0.00 0.10-0.10
Mahabad	c . 0.10±0.00 0.10-0.10
Badawa	a 1.06±0.23 2.07-0.06
Galawezh	a 1.00±0.00 1.00-1.00

Note: Values in each row with different letters are significantly different at $P<0.05$. Values in rows with the same letter are not significantly different.

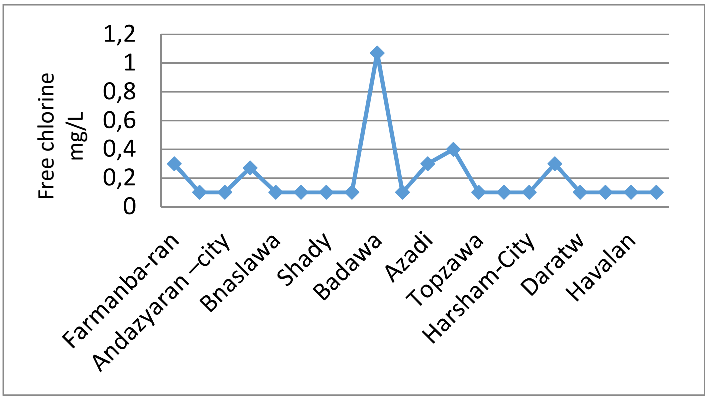

Figure 3. Shows the free Chlorine (mg/L) values at study sites

4. Conclusion:

In conclusion, we have noticed that Badawa and Galawesh quarters had a maximum value of free chlorine which was greater than 0.5 while the values of free chlorine of most quarters were less than 0.2 mg/l level. We recommend that chlorine concentration should be maintained between 0.2 and 0.5 mg/l throughout the water distribution network, also, the well water operator should be well trained to treat with the chlorination process, checking pump systems and daily routine tests will be required monthly.

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