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Relationship between Combined Chlorine (inactive chlorine) and Thermotolerant (Faecal) Coliforms Bacteria in Drinking Water among some Neighborhoods of Al-Najaf City

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Abstract:

Drinking water must not have a special taste or odor, be pure, constant at chemical compound, and not contain pathogenic bacteria, parasites and toxic substances.

In this cross-sectional study was carried out for tested some of Iraqi drinking water parameters for detect if a present correlation between of combined chlorine (in active chlorine) and thermotolerant (faecal) coliforms the indicator bacteria in drinking water of some neighbourhoods in Al-Najaf city, according to recommendations by the World Health Organization (WHO) and Iraqi water parameters in assessment of drinking water quality.

The study was lasted from (1/8/2016 to 1/11/2016). Samples was collected from fifteen neighborhoods of Al-Najaf city, some important chemical drinking water quality parameters, of ((total chlorine, free chlorine, and combined chlorine)), were examined at the field of the sample locations, through use of portable digitize devise and Bacteria of thermotolerant (faecal) coliforms was tested in the laboratory.

The study shows that an increasing of total chlorine mean of (1.95 ppm) more than of free chlorine mean of (1.44 ppm) in all fifteen samples locations of Al-Najaf city.

The present study shows a fifteen neighborhoods of Al-Najaf city under studied that was giving a combined chlorine value of more than (1 ppm) and mean of (1.5 ppm).

The study find out a highly growth of indicator bacteria (thermotolerant coliforms) with a mean of (36.6**)** in all studied sample locations of the fifteen neighborhoods of AL-Najaf city.

There was no any effect of disinfectant action by present free chlorine residual in all fifteen neighborhoods of al-Najaf city although of mean reach at (1.44 ppm).

The study discovered a relationship between a combined chlorine and thermotolerant (faecal) coliforms through direct strongly correlated at (r = 0.967) in all studied sample locations of the fifteen neighborhoods of AL-Najaf city.

The study recommends for an effective measures must be taken to improve diagnostic procedures when monitoring of drinking water in all neighborhoods of Al-Najaf city, and Increasing the efficiency of chlorine as disinfectant and its residual through readjustment of Iraqi chlorine parameters to accommodate with water nature of all governorate.

Key word: Correlation, Combined chlorine, Thermotolerant (Faecal) coliforms bacteria, Neighborhoods, and Al-Najaf city.

Introduction:

Chlorine, is the most common disinfectant in the world, is effective in killing most pathogenic bacteria, parasite and viruses. Municipal potable water supplies are usually chlorinated to provide a residual concentration of 0.5 to 2.0 ppm. Higher chlorine concentrations are needed to kill many bacteria, the need to above 2 ppm. to provide pseudomonas free water [1]. Chlorination is a water treatment that destroys disease causing bacteria, nuisance bacteria, parasites and other organisms [2]. Chlorination removes a large

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amounts iron of and manganese from water and many other mineral and change of mineral to anther from [3].

The amount of chlorine that has reacted with nitrates and is unavailable for disinfection which is called (Combined chlorine), the combined chlorine compounds are responsible for the strong chlorine taste and smell that is sometimes apparent in treated water. Water with little or no combined chlorine and a free residual chlorine level in the 0.3-0.6 mg/L rang usually does not have a strong smell or taste of chlorine [4].

The use of bacteria as indicators of sanitary quality of drinking water probably dates back to 1880 [5]. Traditionally, indicator micro-organisms have been used to suggest the presence of pathogens [6]. Currently, however, we understand a myriad of possible reasons for indicator presence and pathogen absence, or vice versa [7]. Faecal indicator, represent a group of organisms that indicates the presence of faecal contamination, such as the bacterial groups thermotolerant coliforms or *E. coli*. Hence, they only infer that pathogens may be present [8].

The addition of free chlorine compound in an extra large dose in a water treatment station will actually oxidize (destroy, burn off) the combined chlorine. If using completing clean water the chlorine demand will be zero, and there will be no nitrates present, so no combined chlorine will be present. Thus, the free chlorine concentration will be equal to the concentration of chlorine initially added. In natural water, especially surface water supplies such as rivers, organic material will exert a chlorine demand, and nitrates will form combined chlorine. Thus, the free chlorine concentration will be less than the concentration initially added [9]. Drinking water must have no special taste, odor and be pure, constant at chemical compound and not contain a pathogenic bacteria's, parasites and toxic substance [10]. Water has a significant role in satisfying physical, hygienical, sanitary and domestic need for human life, and comprises 63 – 65 % of human body. Water of 2.5–3 litre is needed for human a day, this water satisfying human needs must fully meet hygienically requirements [11]. Every day, 25000 people are dieing because of the shortage of good quality water and one million people are suffering from the communicable and no communicable diseases related to water factors [12].Water have important Role for transmitted many of microorganism that responsible for many diseases like dysentery, typhoid, cholera, poliomyelitis, hepatitis A, respiratory disease and other [13].

Aim of the study: The aim is to tracing if present correlation between combined chlorine (inactive chlorine) and thermotolerant (faecal) coliforms the indicator bacteria in drinking water of some neighbourhoods of al-Najaf city.

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Materials and Methods:

- Period of the Study: The study was lasted from (1/8/2016 to 1/11/2016).

- Place of the Study: The study was conducted in Al-Najaf governorate about 165 Km to the southern of Baghdad capital [14].

- Apparatus and Materials:

Table(1) : Apparatus and Materials used in the present study.

Apparatus	Materials

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1	Portable digital chlorine meter	Free chlorine reagent
2	100 ml container	Total chlorine reagent
3	Incubator	MocConky Broth medium
4	Pipette	Sodium thiosulphate (Na2SO2O3)
5	Sensetive balance	
6	Water bath	
7	Electric oven	
8	Loop	
9	Gaz burner	

- **Neighborhoods and Sampling Collections of Al-Najaf City:**

  - **pilot study:**

All neighbourhood of Al-Najaf city was examined for combined chlorine, to determined which the highly results of combined chlorine for included in the study as recommend of WHO [15].

- **Sampling Collections:**

A- Field Tests:

a. (15) neighbourhoods were included in the study in which represents the highly result of combined chlorine of more than (1 ppm).

b. Each neighborhood was examined for ((total and free chlorine)) by using a portable chlorine meter at the field and then a special formula was applied: (Combined chlorine) = (Total chlorine) - (Free chlorine).

B-Laboratory Tests:

100 ml sample of drinking water per day was collected In the same time from all fifteen neighborhood, for laboratory bacteriological examination ((Thermotolerant (Fecal) Coliforms)), and 7% of Sodium thiosulphate (Na2SO2O3) was applied by Pipette to each water sample for stopped of killing action of the chlorine [16].

Table(2) : The neighborhoods that samples was collected of Al-Najaf city.

1-Al-Yarmok	5- Al-Judiadat	9- Al-Saad	13- Al-Zahraa
2-Al-Makruma	6- Al-Mualmeen	10- Al-Hussain	14--Al-Qadisyia
3-Al-Wafaa	7- old city	11- Al-Salam	15- Al-Naser

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4- Al-Ishtiraky	8- Al-mahdey	12- Al-Shurta	

- **Data Analysis:**

Descriptive and analytical statistics were carried out by utilizing the statistical package for social science (SPSS) version 17.

Pearson correlation coefficient (r), was applied between combined chlorine and bacteriological examinations of thermotolerant (faecal) coliforms bacteria.

- **Results :**

Table (1): The formula that was gave a Combined Chlorine Test Results in (ppm) for All samples Locations of Al-Najaf City

Samples Locations	(Total chlorine ppm) ─ (Free chlorine ppm) = (Combined chlorine ppm)
1- Al-Askery	(2.3) ─ (0.7) = (1.6)
2- Al-Makruma	(1.8) ─ (0.3) = (1.5)
3- Al-Wafaa	(1.9) ─ (0.5) = (1.4)
4- Al-Ishtiraky	(1.8) ─ (0.7) = (1.1)
5- Al-Judiadat	(1.9) ─ (0.2) = (1.7)
6- Al-Mualmeen	(1.9) ─ (0.5) = (1.4)
7- Old city	(2.5) ─ (0.4) = (2.1)
8- Al-mahdey	(2.3)─ (0.6) = (1.7)
9- Al-Saad	(1.7) ─ (0.2) = (1.5)
10- Al-Hussain	(1.8) ─ (0.6) = (1.2)
11- Al-Salam	(1.9) ─ (0.6) = (1.3)
12- Al-Shurta	(2.4) ─ (0.4) = (2)
13- Al-Zahraa	(1.7) ─ (0.6) = (1.1)
14- Al-Qadisyia	(1.8) ─(0.8) = (1)
15- Al-Naser	(2.3) ─ (0.4) =(1.9)

Table (2): Summary statistics shows Total chlorine with Free Chlorine of samples location for all fifteen neighborhoods

Statistics	Total Chlorine (ppm)	Free Chlorine (ppm)
Mean	1.95	1.44
Std. Deviation	± 1.04	± 2.14

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Minimum	**1.5**	**0.2**
Maximum	**2.5**	**0.7**

Table (3): Combined chlorine and bacteriological test values of studied neighborhoods of Al-Najaf city.

Samples Locations	Combined Chlorine (ppm)	Thermo tolerant (Faecal) Coli forms
1- Al-Yarmok	1.6	18
2- Al-Makruma	1.5	38
3- Al-Wafaa	1.4	22
4- Al-Ishtiraky	1.1	28
5- Al-Judiadat	1.7	47
6- Al-Mualmeen	1.4	39
7- Old city	2.1	50
8- Al-mahdey	1.7	55
9- Al-Saad	1.5	39
10- Al-Hussain	1.2	29
11- Al-Salam	1.3	38
12- Al-Shurta	2	49
13- Al-Zahraa	1.1	28
14- Al-Qadisyia	1	27
15- Al-Naser	1.9	42

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Table (3.4): Summary statistics shows combined chlorine with thermotolerant (faecal) coliforms of samples location for all fifteen neighborhoods

Statistics	Combined Chlorine (ppm)	Thermotolerant (Faecal) coliforms (colony)
Mean	1.5	36.6
Std. Deviation	± 3.937	± 1.893
Minimum	1	18

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Maximum	**2.1**	**55**

Table (3.5): The correlation value between Combined Chlorine and Thermo- -tolerant (Faecal) coliforms in all location samples (neighborhoods)

Test Comparison	Pearson Correlation (r)
Combined Chlorine × Thermotolerant (Faecal) coliforms	*** 0.967**

* direct positive strongly correlated

4. Discussion:

The recommended total chlorine concentration after an exposure time of half an hour under non-emergency conditions was (0.6-0.8 ppm) at the end of the line points [17]. Chlorination of water relatively free from suspended matter at range from (0.5-1.0 ppm) may require giving the residual chlorine in range of (0.2-0.3 ppm) [18].

The professional operators that work in public drinking water treatment plant responsible of determination of the time and quantity of chlorine which were needed for excellent water disinfection, and keeping an acceptable of chlorine residual level at the end point of pipelines [9].

The study found out the presence of human faecal contamination by used of indicator bacteria (thermotolerant (faecal) coliforms), in fifteen neighborhood of Al-Najaf city although in presence of maximum value of total chlorine (2.5 ppm) and maximum of free chlorine was (0.8 ppm). **5**

And there was irregularity of chlorine residual that represent total and free chlorine value, which was lead to increased of combined chlorine in many different samples locations (neighborhood) of Al-Najaf city with the maximum value (2.1 ppm), this defect for these results above might be due to the low of knowledge of water treatment plant worker especially when determined the right quantity of chlorine that must to be added to drinking water, or the leakage of some drinking water pipeline in some neighbourhoods that was leading to connection with sewage or ground water ammonia make binding with active chlorine that was converted it to combined chlorine (inactive form), or the increasing of combined chlorine might be due to the lowering of the contact time (the appropriate time that the chlorine required to action for disinfection), and the pumping water with chlorine in a random way as directly to the distribution network pipelines.

In the present study, there was a finding that the total chlorine mean was higher than the free chlorine for all studying location samples (neighborhoods) of al-Najaf City (1.95 and 1.44 ppm) respectively, Clasen, from university of Minnesota in united state, showed that, when the total chlorine level was higher than the free chlorine, it is obvious that combined chlorine is

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present, explains these results. In that case, we need to shock or super chlorinate of drinking water distribution network [19].

In the present study, there was thermotolerant (fecal) coliforms in represent bacteriological pollution in spite of the precedence of residual chlorine, there was found of many pollution foci of thermotolerant (faecal) coliforms of fifteen neighborhoods in Al-Najaf city of the minimum (18) and maximum (55), these results might indicate that treated water was in need of a new standard for chlorine quantity to be add and this result agrees with A. Tavakoli in Iran [20], in his study in 2005, he found that the WHO standards of total chlorine was not enough for killing of all microorganisms in drinking water.

The study found out, that there was a strongly positive direct correlation (r = 0.967) between combined chlorine and Thermotolerant (Faecal) coliforms bacteria in (15) neighbourhoods of Al-Najaf city, which mean the increasing of combined chlorine value more than (1 ppm) leading to increasing chance for finding of indicator bacteria of thermotolerant (faecal) coliforms (human faeces pollution), and this correlation explained the extremely direct proportion in the same samples locations. Many reasons that standing behind this correlation result, which was leading to interrupting or stopping of disinfectant action of chlorine in all fifteen neighborhoods, one of it, the increasing of total chlorine more than free chlorine because of poor purification of drinking water and the leakage in drinking water pipelines or connection with municipal pipeline.

This correlation was considered a first explore that was approved practically in a present study, and no any researcher was use the same aim or examine all types of residual chlorine in drinking water.

-Conclusions and Recommendations

- Conclusions: The following conclusions can be derived from this study:

1- The study shows an increasing of total chlorine in all fifteen samples locations of Al-Najaf city.

2- The present study shows a fifteen neighborhoods of Al-Najaf city that was giving a combined chlorine value of more than (1 ppm) and mean of (1.5 ppm).
3- The study found out a highly growth of indicator bacteria (thermotolerant coliforms) with a mean of (36.6**)** in all studied sample locations of the fifteen neighborhoods of AL-Najaf city.
4- There was no any effect of disinfection action by free chlorine residual in all fifteen neighborhoods of al-Najaf city although of mean reach at (1.44 ppm).
5- The present study found out a relationship between a combined chlorine and thermotolerant (faecal) coliforms through direct strongly correlated at (r = 0.967) in all studied sample locations of the fifteen neighborhoods of AL-Najaf city.
6- The drinking water was unfit for human consumption in all sample locations (neighborhoods) of Al-Najaf city.

-Recommendations:

1. Effective measures should be taken to improve diagnostic procedures and digitized devises when monitoring of drinking water in all neighborhood of Al-Najaf city .
2. Improve professional skills of Ministry of Health inspectors.

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3. Establishing emergency program that deals quickly with the bacteriological drinking water contamination when confirmed in any part of community water system.
4. Increasing of the efficiency of chlorine disinfectant and residual through adjustment of the present Iraqi chlorine standards.

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