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Miriam Balaban, Editor

36 Walcott Valley Drive, Hopkinton, MA 01748, USA
Tel. +39 348 8848 406 (mobile), Fax +1 928 543 3066, E-mail: dwt@deswater.com, balabanmiriam@gmil.com

Ayat Hussein Mahdi
Baghdad University of Technology
Building and Construction Dept.
Sanitary and Environmental
Baghdad
Iraq

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DWT **9710** The effect of water treatment stages in Al-Wathba water treatment plant in Baghdad on the bacterial growth (applied study)

Mohammed Ali I. Al-Hashimi, Ayat Hussein Mahdi, Rana Jawad Kadhim

Dear Authors,

We are pleased to inform you that your revised paper has been accepted for publication in *Desalination and Water Treatment*.

With best wishes,

Miriam Balaban

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The effect of water treatment stages in Al-Wathba water treatment plant in Baghdad city on the bacterial growth (applied study)

Mohammed Ali I. Al-Hashimi[a], Ayat Hussein Mahdi[a] & Rana Jawad Kadhim[a]

[a] Building and Construction Department, Sanitary and Environmental Engineering Branch, University of Technology, Baghdad, IraqEmail:
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Mohammed Ali I. Al-Hashimi*, Ayat Hussein Mahdi, Rana Jawad Kadhim

Building and Construction Department, Sanitary and Environmental Engineering Branch, University of Technology, Baghdad, Iraq
Email: mohashimi2003@yahoo.com

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ABSTRACT

The aim of this research is to study the biological pollution in Al-Wathba water treatment plant stages (new extension) by taking water samples from the river, sedimentation tank, sand filter, pressure filter, and from three residential areas (Al-Atebaa neighborhood, Al-Amen neighborhood, and Al-Shorja), with the examination of bacterial growth, temperature, pH, and turbidity in each stage. Weekly samples have been taken for the period from January 2011 to May 2011 by studying the bacterial existence using total plate count, and also by testing for total and fecal coliform using presumptive and confirmed test because it is the evidence for bacterial pollution. There was high percentage of pollution in the sedimentation tank and less amount in sand filter due to lack of periodic cleaning. Fecal coliform reduced after pressure filtration; small amounts of chlorine were added to the filter to reduce the bacterial growth in filter media. After chlorination the removal efficiency was 99.99%. It was noticed that the chlorine dose added for disinfection was so high that it reached up to 3.5 mg/ L, which is dangerous especially for people near water treatment plants.

Keywords: Total plate count; Fecal coliform; Chlorination; Bacterial growth

1. Introduction

Water has long served as a mode of transmission of diseases. The most important of the waterborne diseases are those of the intestinal tract, including typhoid fever, paratyphoids, dysentery, infectious hepatitis, cholera, and some parasitic worm diseases [1].

Drinking water should also have a reasonable temperature [2].

It is not practical to test the water for all organisms that it might possibly contain. Instead, the water is examined for a specific type of bacteria which originates in large numbers from human and animal excreta and whose presence in the water is indicative of fecal contamination [3].

The most basic test for bacterial contamination of a water supply is the test for total coliform bacteria. Total coliform counts give a general indication of the sanitary condition of a water supply [4].

Total coliforms include bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste [4].

Fecal coliforms are a group of total coliforms that are considered to be present specifically in the gut and feces of warm-blooded animals. Because the origins of fecal coliforms are more specific than the origins of more general total coliform group of bacteria, fecal coliforms are considered as a more accurate indication of animal or human waste than the total coliforms [4].

Escherichia coli (*E. coli*) are the major species in the fecal coliform group; so, they are considered to be the

*Corresponding author.

best indicator of fecal pollution and the possible presence of pathogens [4].

2. Bacteriological health effect

The pathogenic agents involved protozoa which may cause disease that vary in severity from mild gastroenteritis to sever and sometimes fatal diarrhea, dysentery hepatitis, typhoid fever, cholera, and other illness. Most of them are widely distributed throughout the world [5].

It is not only by causing infection that microorganisms in drinking water affect human health. In some circumstances, cyanobacteria can produce toxins that may remain in water even when the cyanobacteria themselves are removed [5].

Total coliform bacteria ferment lactose at 35 or 37°C with the production of acid, gas, and aldehyde within 24–48 h. Fecal coliforms (thermotolerant coliform) are a subgroup of total coliforms having same properties except that they tolerant and grow at higher temperatures of 44–45°C [6].

Finally, there are some organisms whose presence in water is a nuisance but which are of no significance for public health [7].

3. The effect of water parameters on bacterial growth

Bacteria can enter water supply through infiltration by flood waters or by surface runoff. Flood waters commonly contain high levels of bacteria. Small depressions filled with flood water provide an excellent breeding ground for bacteria [8].

Treatment effectiveness is a function of disinfectant dose, contact time, temperature, and sometimes pH. Chemical disinfection to inactivate pathogens is an important treatment barrier [9].

The activity of a disinfectant may be greatly affected by factors such as dilution, temperature, pH, or the presence of organic matter. A disinfectant needs appropriate conditions, at a suitable concentration, for an adequate period of time [10].

An increased risk of bladder cancer appeared to be associated with the consumption of chlorinated tap water [11].

Careful attention to pH control is necessary at all stages of water treatment to ensure satisfactory water clarification and disinfection. For effective disinfection with chlorine, the pH should preferably be less than 8 [12].

The pH of the water markedly influenced the survival of bacteria. The addition of lime to the raw water was an effective method of pH bacteria control. The results of a study done by Martin et al. illustrate the delicate balance that can exist between bacterial growth, pH, and chlorine residue [13].

Increasing the pH level over 7.2 can negatively affect chlorine action; it decreases its action on killing bacteria [14].

Water temperature directly or indirectly affects all the factors that govern microbial growth. Temperature influences treatment plant efficiency, microbial growth rate, disinfection efficiency, decay of disinfectant residuals, corrosion rates, and distribution system [15].

At temperatures above 15°C, the growth of nuisance organisms in the distribution system becomes a problem and could lead to development of unpleasant taste and odors [16].

The ideal temperature of water for drinking purpose is 5–12°C; above 25°C, water is not recommended for drinking [17].

To define the interrelationship between elevated turbidities and the efficiency of chlorination in drinking water, experiments were performed to measure bacterial survival, chlorine demand, and interference with microbiological determinations. Results indicated that disinfection efficiency was negatively correlated with turbidity and was influenced by season, chlorine demand of samples, and the initial coliform level [18].

Turbidity is of great importance, first because of aesthetic consideration and second because pathogenic organisms can hide on (or in) tiny colloidal particles [19].

Turbidity in rivers can change from 10 to over 4,000 NTU [20].

Turbidity level for treated water should not exceed 5 NTU, and should be under 1 NTU for efficient disinfection with chlorine [21].

4. Previous studies

Studies have been done to study water quality in water treatment plants. All these studies have indicated that water quality of the Tigris River in Baghdad is affected by the discharge of untreated sewage and wastes from industries and hospitals in to it.

Al-Malikey studied the effect of pollution of the Tigris River. He indicated that Al-Wathba water treatment plant, which is located in the middle of Baghdad, was not suitable for use as a source of drinking water due to exceeding number of total coliform bacteria [22].

Alwan stated that the bad quality of the drinking water can be attributed to two sources: first, the embargo which was imposed on our country lowered the efficiency of water treatment plants, and second