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Bacteriological Quality of Drinking Water at Different Cities in Egypt

Mai G. Abd-Elhameed; M. A. E. Selim; Aida H. Afify* and F. I. A. Hauka

Microbiology Dept ., Fac. of Agric ., Mansoura Univ., Mansoura , Egypt .

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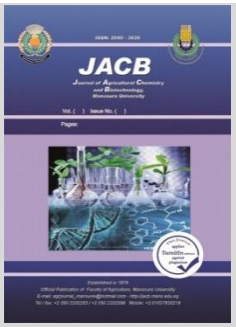

ABSTRACT

Bacteriological examinations were carried on four types of water samples which collected from tap water, river Nile water, ground water and bottled water, at different cities in Dakahlia and Damietta Governorates, Egypt during 2017/2018 in order to determine the level and total count of bacterial isolates were present in our water collected samples . These bacterial groups were described as coliform bacteria, fecal coliform bacteria, and fecal streptococci, according to total bacterial counts methods. Generally,the highest number of total bacteria was found in Damietta, after that the number of total bacteria were presented in Sherbin. On the other hand, isolated bacteria were found to be lower counted than Mansoura water samples.

***Keywords*:** River Nile water, Tap water, Ground water, Bottled water, Coliform bacteria, Streptococci, Dakahlia and Damietta governorates.

INTRODUCTION

Our survival as a species mainly depends on how we manage and use the environment today. If we do well, the quality of life will improve, if not, disaster awaits us. Answers to most questions we face depend on understanding many environmental disciplines. Water can be considered as the most important natural resource that can be utilized by man to develop his prosperity as well as his essential needs. Water quality management, water pollution control and environmental protection are the main issues to save our future (Chin, 2010).

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and groundwater wells. Contaminants that may be present in source water include: microbial contaminants, inorganic contaminants, pesticides and herbicides, organic chemical contaminants and radioactive contaminants Therefore, a more logical approach is the detection of organisms normally present in the feces of humans and other warm-blooded animals as indicators of fecal pollution as well as water treatment and disinfection efficacy. The indicators should respond to natural environmental condition in water treatment processes. The indicator should be easy to isolate, identify and enumerate from the aquatic environment (WHO, 2008). In general, the greatest microbial risks are associated with ingestion of water contaminated with human and animal excreta. Most of the mortality and morbidity associated with water related disease especially in developing countries are due directly or indirectly to infectious agents which infect man (Edagawa *et al*.,2009).

In Egypt, the resources of drinking water are the Nile water, ground water and also the rain water. Nile water comprises about 97% of the renewable water supplies in Egypt many studies demonstrate the water supplies and demands in Egypt. The major groundwater aquifers stretch in the western desert and Sinai, beneath and west of the Delta (Natroun Valley and Cairo-Alexandria desert road), Salheyia, beneath Upper Egypt. This water is renewable because it originates from the leakage of Nile and drainage waters. Within the western part from Alexandria city to El-Sallum, the northern coast receives a modest amount of winter rainfalls with a mean level of 150 mm/yr. It diminishes to 100 mm/yr to the east in El-Arish region then rises up again to 250 mm/yr eastern of El-Arish at Rafah, northeast Sinai.

Bottled water could be contaminated in different stages. It may contain contaminants originating in the source waters, as well as substances which may have entered the water in the treatment plant or the bottling process. Contamination could also result from the continuous contact with the containers the water is stored in (Bichai *et al*.,2014). The presented research was carried out to evaluate, drinking water resources in Dakahlia and Damietta governorates according to microbial standards in four regions of Sherbin, Mansoura, Met Khamis and Damietta.

MATERIALS AND METHODS

Sources of water samples

Water samples were collected seasonally from four different types of water namely, (Tap water, Ground water, River Nile water and bottled water).Water resources were represented by 320 samples of them, 80 tap water, 80 ground water, 80 river Nile water and four different marks of bottled water ,20 samples from every mark. The samples were collected from different region during four periods to (winter, spring, summer and autumn) during 2017 and 2018 seasons.

Ground water samples were not disinfected before pumping to the drinking water pipeline.

* **Corresponding author.**
E-mail address: aidaafify@yahoo.com
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Bacteriological examinations

Samples were collected for bacteriological examinations in sterilized glass bottles with screw-top closures 500 ml volume, contained Sodium thiosulfate ($Na_2S_2O_3$), Sodium thiosulfate is a satisfactory dechlorinating agent that neutralizes any residual halogen and prevents continuation of bactericidal action during sample transit. (12.41g Sodium thiosulfate were dissolved in 1-liter distilled water) and sterile in a bottle in autoclave at 121°Cfor 30 min, preserved in ice-box and examined within 3 hours from collection. (APHA, 2012)

Total bacterial counts

The counting of the total bacteria was determined by two methods:

1- Pour plate method as described in (APHA, 2012) by used media (R2A) agar

Use for pour plate, spread plate and membrane filter methods. This low-nutrient agar gives higher counts than high-nutrient formulations. Media used were obtained in a dehydrated form, Difco USA. Colonies counted by determining the plate count that having 30 to 300 colonies/plate (Swaroop 1951).

2- Membrane Filter (MF) Technique

It was determined according to the method described in Dunling and Wanda (2008). This method used to detect total coliform bacteria, fecal coliform bacteria and fecal streptococci. The deference of the method of detection is media, time and temperature of incubation (APHA, 2012).

RESULTS AND DISCUSSIONS

Results

Bacteriology of water resources

For biological safety evaluation of the drinking water from different sources of two governorates, the four sources of water from Sherbin, Mansoura, Met Khamis and Damietta were tested via microbiological culturing techniques for the count of the bacteria from the different water sources. The isolated pathogenic bacteria (Total count bacteria, Fecal bacteria and coliform bacteria) was used as an indicator of water pollution and safety of drinking water.

Bacterial contamination in tap water

The bacterial total count in the different water resources was estimated by many methods and indicators using filtering membrane for all total count of bacteria, and differentiated media for the coliform and fecal bacteria, the isolated bacteria was incubated in two different temperature of (22-37ºC), the total bacteria in the four cities (Sherbin, Mansoura, Met Khamis and Damietta) in the four seasons of the year (Summer- Autumn- Winter- Spring)., the highest significant number of the total bacterial count in the four seasons of the year was the cfu/ml numbers of the tap water collected from Damietta city that were 73, 55, 59 and 66 at Summer, Autumn, Winter and Spring respectively at the 37ºC and 92, 87, 66 and 59 at the same seasons respectively at 22ºC. The water from Sherbin followed the Damietta water count of total bacteria incubated at 37ºC, it was 34, 29, 30 and 22 cfu/ml at Summer, Autumn, Winter and Spring, respectively. followed by Meet Khamis water total count bacteria that incubated at 22ºC. Total count bacteria of Meet Khamis water had the higher significant total bacterial than the water from Mansoura city with (22, 37, 20, and 25) cfu/ml at Summer, Autumn, Winter and Spring respectively with the comparison of 25, 18, 13, and 16 cfu/ml at 37 ºC at the four seasons respectively (Fig. 1)

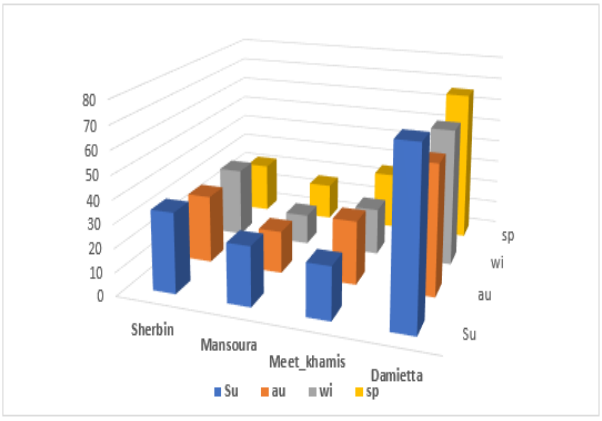

Fig. 1. Total bacterial count (CFU/ml) of tap water at different seasons from different cities in two Governorates at 37ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

The contamination of the different water sources with pathogenic bacteria that indicate sewage contamination of the drinking water was estimated using some classical bacterial count as fecal, coliform and streptococcus total bacterial count of certain water source. For the tap water evaluation in four cities, Sherbin, Mansoura, Met Khamis and Damietta tap water was collected at Summer, Autumn, Winter and Spring seasons and cultured for microbiological evaluation. The total coliform count of Damietta tap water had the highest significant CFU/ 100 ml count in Summer, Autumn, Winter and Spring with 66, 46, 51 and 55, respectively that followed by Met Khamis tap water that had 32,29, 27 and 31, respectively. On the other hand, Mansoura tap water samples had the most significant low total count of 20, 15, 10 and 12 in the four seasons, respectively followed by the Sherbin tap water with 30, 25, 27 and 20 in the four different seasons. No fecal coliform or fecal streptococci bacteria was detected in the tap water of the four different cities (Fig. 2 and 3).

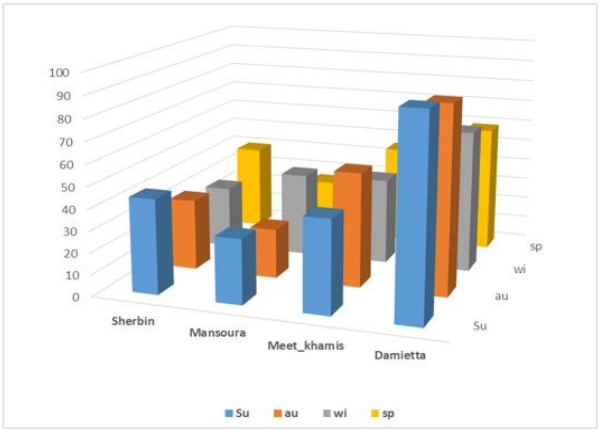

Fig. 2. Total bacterial count (CFU/ ml)of tap water at different seasons from different cities in two Governorates at 22ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

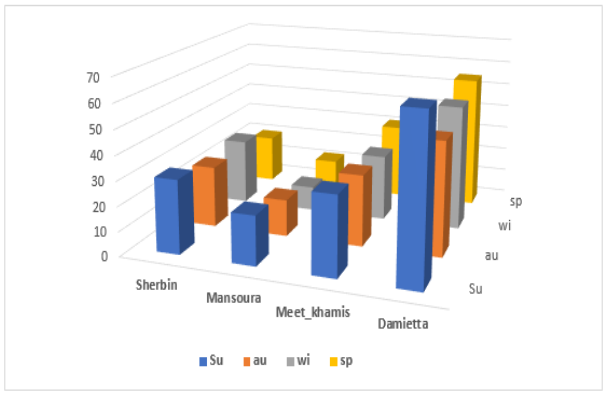

Fig. 3. Total Coliform count (cfu/ ml) of tap water at different seasons from different cities in two Governorates.(Su= summer, au= autumn, Wi= winter, Sp= spring).

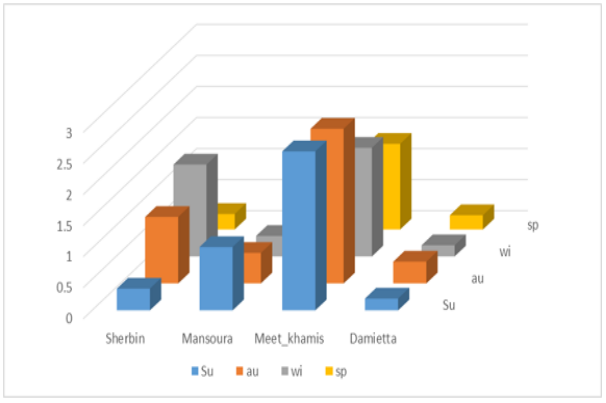

Fig. 5. Total bacterial count (cfu×10^4 /100 ml) of ground water at different seasons from different cities in two Governorates at 22ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

Bacterial contamination of the ground water

The ground water (source of drinking water) of four cities Sherbin, Mansoura, Met Khamis and Damietta of two governorates were evaluated for total microbial contamination as a safety indication of drinking water, in addition to total bacteria count, and some classical bacterial count as fecal, coliform and streptococcus as well as total bacterial count of certain water source was evaluated. The total bacterial count of water collected from Met Khamis city had the high total bacterial count at the four seasons of Summer, Autumn, Winter and Spring with 2.34, 2.17, 2.43 and 1.98 cfu×10^4/100 ml, respectively which incubated at 37ºC, and 2.56, 2.49, 1.75 and 1.38 cfu×10^4/100 ml at the same seasons respectively at 22ºC. In autumn the bacterial count was the highest with 1.12 cfu×10^4/100 ml at 37ºC, on the other hand the count of total bacteria of Mansoura ground water samples at Summer season that isolated and incubated at 22ºC was 1.02 cfu×10^4/100 ml. The lowest total bacterial count number of ground water in Dakahlia governorate was the Damietta ground water with 0.29, 0.32, 0.12 and 0.33 1.02 cfu×10^4/100 ml respectively at the different four seasons incubated at 37ºC and with 0.19, 0.35, 0.18 and 0.23 respectively when incubated at 22ºC (Fig. 4 and Fig. 5).

The microbial contamination of ground water of two governorates with coliform, fecal and streptococcal pathogenic bacteria was determined with several methods that might be used as indication for water sewage contamination. The coliform bacterial count and fecal coliform bacterial count in Summer, Autumn, Winter and Spring were recorded at Sherbin, Mansoura, Met Khamis and Damietta . The ground samples water of Damietta showed the most high total coliform and fecal coliform bacterial count with 3.40, 2.90, 3.20 and 4.00 cfu/100 ml at Summer, Autumn, Winter and Spring, respectively and 3.42, 3.51, 2.93 and 2.80 cfu/100 ml at four seasons, respectively. On the other hand, Sherbin ground water samples recorded the following higher total coliform bacterial with 2.70, 1.90, 2.00 and 2.50 cfu/100 ml in four seasons, respectively but the fecal coliform bacteria count of Met Khamis ground water was the highest bacterial count followed Damietta ground water with 2.9, 2.70, 2.5 and 1.39 cfu/100 ml in the four year seasons respectively. The ground water samples collected from Mansoura had the lowest coliform bacterial count and fecal coliform bacterial count. No streptococcal bacteria were detected in the ground water collected from the four cities in two governorates (Fig. 6 and Fig. 7).

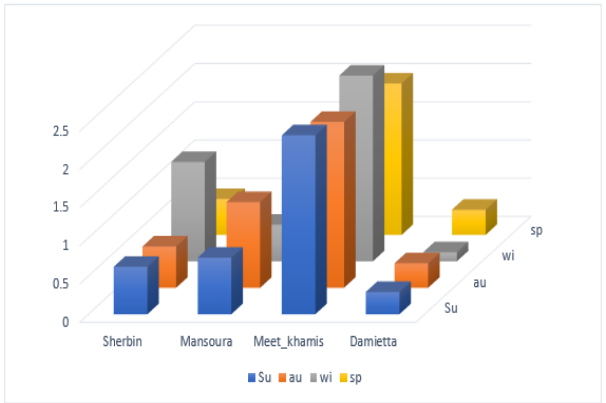

Fig. 4. Total bacterial count(cfu×10^4 /100 ml) of ground water at different seasons from different cities in two Governorates at 37ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

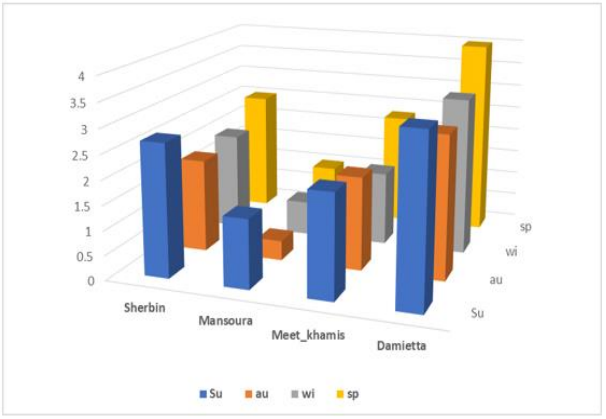

Fig. 6. Total coliform count(cfu/100 ml) of ground water at different seasons from different cities in two Governorates. (Su= summer, au= autumn, Wi= winter, Sp= spring).

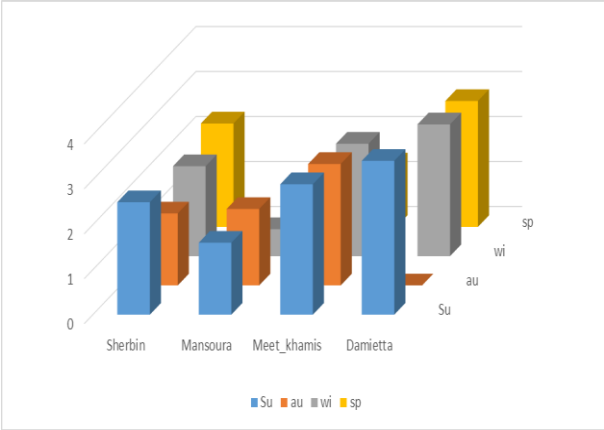

Fig. 7. Total fecal count (cfu/100 ml) of ground water at different seasons from different cities in two Governorates. (Su= summer, au= autumn, Wi= winter, Sp= spring).

Bacterial contamination of River Nile water

The drinking water of River Nile water source from four cities Sherbin, Mansoura, Met Khamis and Damietta in two governorates were evaluated for microbial contamination using some classical indicators of total count bacteria (coliform bacteria, fecal coliform bacteria and fecal streptococci bacteria) at four seasons . The total bacterial count of Sherbin was the highest total bacterial count at 37ºC and 22ºC with 3.60, 3, 2.36 and 2.30 cfu×10^5/100 ml at the four seasons, respectively, and with 3.00, 3.15, 2.28 and 3.22 cfu×10^5/100 ml, respectively. The following microbial contaminated water was the water samples of Damietta at the four seasons at 37ºC and 22˚C with 2.40, 2.29, 2.20 and 2.35 CFU×10^5/100 ml respectively, at 37˚C and 2.00, 1.22 and 1.81 CFU×10^5/100 ml. The following water in the total bacterial count was the water samples collected from Met Khamis city and Mansoura city (Fig. 8 and Fig. 9).

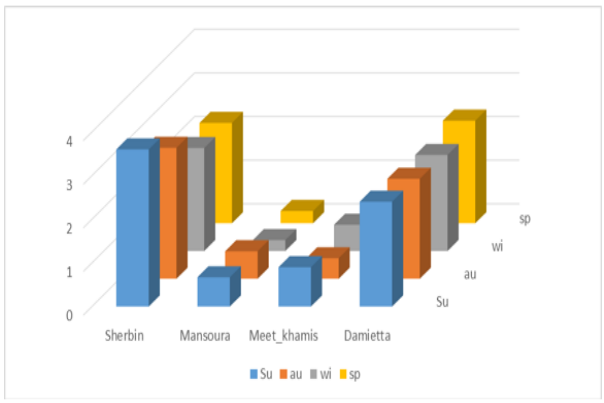

Fig. 8. Total bacterial count (cfu×10^5 /100 ml) of River Nile water at different seasons from different cities in two Governorates at 37ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

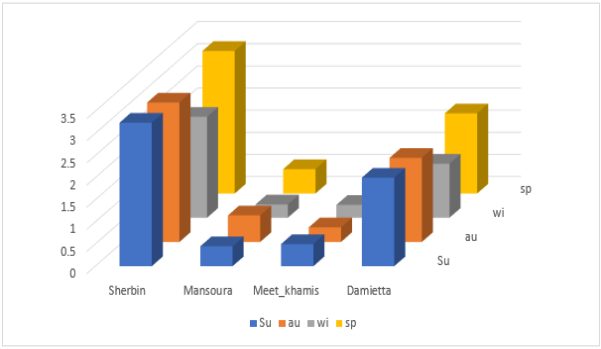

Fig. 9. Total bacterial count (cfu ×10^5 /100 ml) of River Nile water at different seasons from different cities in two Governorates at 22ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

The microbial contamination of River Nile water was determined via coliform, fecal and streptococcal pathogenic bacteria was determined which several methods that might be used as an indication for water sewage contamination. The coliform bacterial count and fecal coliform bacterial count in Summer, Autumn, Winter and Spring was recorded at Sherbin, Mansoura, Met Khamis and Damietta cities . The total coliform count of Sherbin was the most significant count with 5.09, 3.48, 3.70 and 300 cfu×10^4/100 ml, respectively, fecal coliform count 4.20, 3.30, 4.43 and 5.10 respectively and fecal streptococci count was 3.37, 2.50, 3.01 and 3.44, respectively. The water collected from Damietta River Nile had the following count of bacteria, the total coliform bacteria was 3.07, 2.71, 3.32 and 2.49 CFU×10^4/100 ml respectively, fecal coliform count was 2.49, 1.80, 2.18 and 3.04 CFU×10^4/100 ml respectively and fecal streptococci count was 2.55, 3.01, 3.23 and 2.70 CFU×10^4/100 ml respectively. The following water in the lowest total bacterial count was the water samples collected from Met Khamis city and Mansoura city with (Fig. 10,11 and 12).

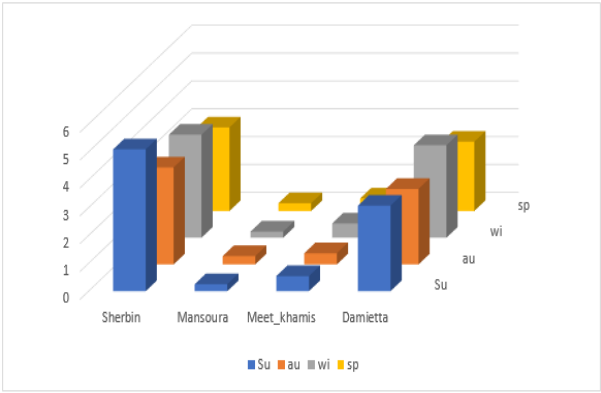

Fig. 10. Total coliform count (cfu ×10^4 /100 ml) of River Nile water at different seasons from different cities in two Governorates. (Su= summer, au= autumn, Wi= winter, Sp= spring).

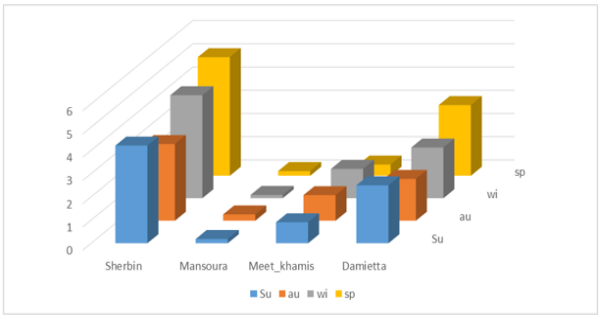

Fig. 11. Total fecal count (cfu ×10^4 /100 ml) of River Nile water at different seasons from different cities in two Governorates. (Su= summer, au= autumn, Wi= winter, Sp= spring).

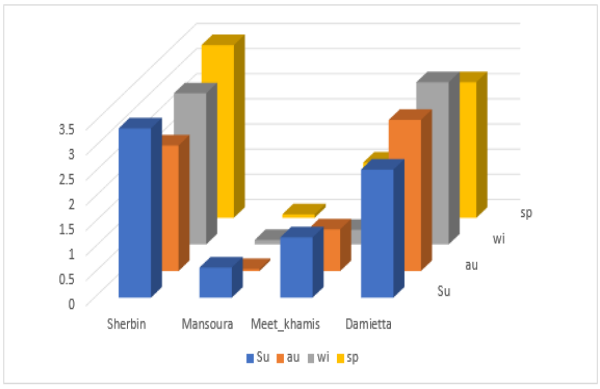

Fig. 12. Total fecal streptococci count (cfu ×10^4 /100 ml) of River Nile water at different seasons from different cities in two Governorates. (Su= summer, au= autumn, Wi= winter, Sp= spring).

Bacterial contamination of Bottled water

Finally, bottled water samples were evaluated for microbial contamination with bacteria, total bacterial count at four seasons of Summer, Autumn, Winter and Spring was recorded at 37ºC and 22ºC. The total bacterial count at 37ºC was 2.9, 0.9, 0.4 and 2.01 cfu/ml respectively, and the total bacterial count at 22ºC was 2.70, 1.00, 0.02 and 0.50 cfu/ml respectively, the most high count was in summer at 37ºC and 22ºC. On the other hand, the classical bacterial indicators as total coliform count was 0.05, 0.01, 0.20 and 0.03 cfu /ml in winter season, but No fecal or streptococcal coliform bacteria were recorded counts in tested bottled water (Figs. 13, 14 and 15).

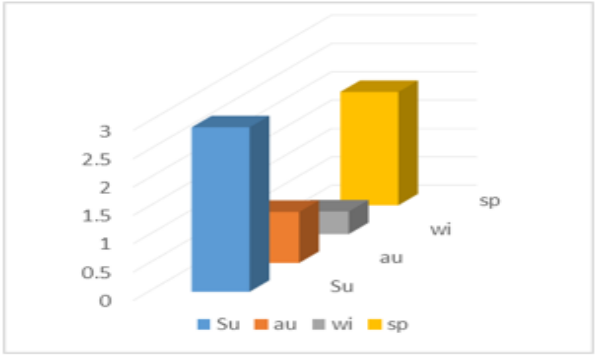

Fig. 13. Total bacterial count (cfu / ml) of Bottled water samples at different seasons at 37ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

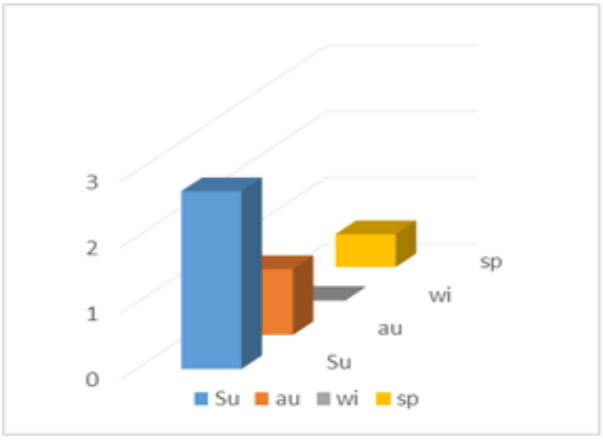

Fig. 14. Total bacterial count (cfu / ml) of Bottled water samples at different seasons at 22ºC. (Su= summer, au= autumn, Wi= winter, Sp= spring).

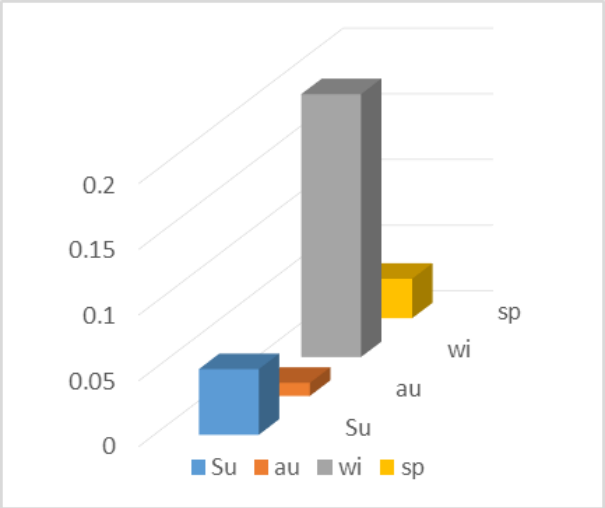

Fig. 15. Total coliform count (cfu / ml) of Bottled water at different seasons. (Su= summer, au= autumn, Wi= winter, Sp= spring).

Discussion

Drinking-waters should be safe for lifetime use, taking account of differing sensitivities that occur across life stages, but all are not necessarily suitable for individuals suffering from certain specific immunocompromising disorders. Piped drinking-water supplies typically involve source abstraction, treatment and distribution. The latter may include ancillary devices at domestic or institutional levels, such as softeners, activated carbon treatment, vending machines, dispensers, etc. Drinking-waters also include those obtained from non-piped sources, such as from springs and community wells, in bottles and as ice (WHO, 2008).

As in our work recorded, number of studies have yielded virtually the same characteristic spectrum of bacterial strains in water. Our results showed that the most contaminated source of drinking water with fecal bacteria in Dakahlia and Damietta governorates was the River Nile water that proved the sewage contamination of the River Nile water.

These results were in accordance with those obtained by Ali *et al.*, (2008), They found that the log

counts of total coliform, fecal coliform and fecal streptococci were 4.1, 2.3 and 2.5 MPN-index/100 ml, respectively, in Nile water samples at Giza drinking water treatment plant. Other works found that the log count of total coliform in Nile water reached 4 - 6 MPN-index/100 ml. These relatively high counts might be due to pollution by 34 industrial facilities discharging to the Nile water between Aswan and Cairo (Saleh, 2009). In another study, total and fecal coliforms were detected in Nile water at Greater Cairo in 100% of the tested samples reaching 104 and 103 cfu/100 ml respectively. Moreover, some other studies reported that domestic and industrial wastewater, agriculture waste environment are sources of fecal bacterial to rivers.

From this study, the results showed the importance of usual microbial evaluation of the drinking water for human safety and health.

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التقييم البكتريولوجي لمياه الشرب بمناطق مختلفة في مصر

مي جمال عبد الحميد , محمد عبد الله العوضى سليم , عايده حافظ عفيفى وفتحى اسماعيل على حوقه

قسم الميكروبيولوجي – كلية الزراعة – جامعة المنصورة – المنصورة – مصر

أقيمت الدراسات البكتريولوجية علي أربعة انواع من مصادر المياه المختلفة في مصر والتي قد جمعت من مياه الصنبور، ومياه نهر النيل، والمياه الجوفية وزجاجات المياه المعدنية من مدن مختلفة في محافظتي الدقهلية ودمياط خلال العامين 2017 – 2018 وذلك لقياس معدلات واعداد البكتريا في تلك المصادر وتقييمها . وقد وصفت البكتريا المعزولة محل الدراسة على أنها بكتريا الكوليفورم ، والفيكال كوليفورم بكتريا، والبكتريا السبحية وذلك تبعا للطرق المختلفة لعد وعزل البكتريا من المياه ولقد اوضحت نتائج الدراسة علي ان اعلى اعداد البكتريا كانت في مدينة دمياط تليها مدينة شربين على الجانب الآخر كانت المنصورة هي الأقل فى اعداد البكتريا المعزولة من المياه.