Microbial and Physicochemical Assessment of Water Quality Reserving in Silver Utensils

Issam Mohammed Ali Alradiny [1]   **Sabah Malik Habeeb Al-Shatty**[2] **Jumaah Abdulzahra Nafea** [1]

[1]Department of Soil Science and Water Resources, College of Agriculture, University of Basrah, Iraq

[2]Department of Food Sciences, College of Agriculture, University of Basrah, Iraq

Email: issam.abdalkareem@uobasrah.edu.iq , sabah.habeeb@uobasrah.edu.iq , Jumaah.naffea@uobasrah.edu.iq

Abstract

Raw water samples were collected without treatment from the Shatt Al – Arab river in Al-Baradeiah area. Through the study, it is measured the biological and physicochemical variables after retaining samples in silver utensils which are: Total bacterial count, total coliform bacteria, total fecal coliform bacteria, count of fungi (yeasts and molds) as well as Total Dissolved Solids, Electrical Conductivity, and pH . At limited time intervals where the residence time of water samples in the silver utensils was (0 , 10 , 15 , 30 , 60) minute .The results showed that the highest percentage of eradication of total bacteria , yeasts and molds was at the first ten minutes whereas the largest percentage of eradication of total coliform bacteria and fecal coliform bacteria was at the first fifteen minutes .The study also showed that eradication of all studied microbes was at a period of sixty minutes with very few of total bacteria . The study showed that the preserved water in silver utensils had no effect on changing the physicochemical properties of the studied samples. Through the study , it was noticed that there was an inverse relationship between the residence time with the studied microbes where it was between (- 0.575 to - 0.753) whereas the relationship between the studied microbes themselves was a strong direct relationship that ranged between   (0.878 to 0.999).

Keywords: Water Quality, Coliform Bacteria, Retention Time, Biological Parameters.

Introduction

For getting safe water is a worldwide concern. Fresh water sustains human health, economic development and food production. Water pollution increases due to the increase in population and increase in sources of pollution as a result of industrial, urban and civil development (1). Where 80% of wastewater is discharged to fresh water in water surfaces

without treatment (2). Statistics indicate that about 80% of diseases are directly related to water pollution, as more than a third of deaths in developing countries are caused by use of polluted water (3,4). As well drinking water pollution plays a major role in the spread of deadly diseases and epidemics such as diarrhea and typhoid which leads to the death of millions of children under the age of five annually (5).

Water pollutants are removed either by filtering or by desalination to improve the physicochemical properties (6,7) While microbial contaminants are removed either by using chemicals such as chlorine gas, sodium hypochlorite, calcium hypochlorite , chlorine dioxide , iodine and ozone or by using a physical method such as boiling , ultraviolet rays , solar energy , metal ions such as silver(8). The examination of the total coliform bacteria and fecal coliform bacteria is carried out which is accredited as an evidence of water contamination with pathogenic microorganisms, and then conforms to the specifications approved by the world health organization and the environmental protection agency (9,10,11)for knowing the efficiency of silver utensils in sterilization water and removing contaminants.

It may be impossible to use chemical methods and some physical methods for eliminating microbial contaminants either because of their unavailability or because of wars and emergency conditions, lack of electrical or thermal energy. Therefore, other methods and techniques should be used and knowing their positives and negatives such as silver ions and silver utensils, and in the event that method is effective in eliminating microorganisms, it should be determined the time required for the water to stay in silver utensils to eliminate microbes .This study came with the aim of evaluate the microbial and physicochemical quality of water preserved in silver utensils to reach the state of water acceptability and the possibility of using water for domestic uses . As well as comparing the water stored in silver utensils after a specified residence time with the specifications of drinking water according to the world health organization (WHO) and the United State Environmental Protection Agency (EPA).

Materials and Methods

Samples were collected from Al-Baradeiah water purification plant without treatment which is supplied with the water from Shatt – Al – Arab river with three replicates in colorful and sterile glass bottles. The water was kept in silver utensils type (MATFINISH–95621) for specific periods of time where the residence time of the water in these utensils was (0 , 10 , 15 , 30 , 45 , 60) minutes.

Biological and physicochemical tests were carried out in the laboratory. The biological tests included estimating the total number of bacteria where was used plates method. After the samples were shaken well and a series of decimal dilutions were made from them after 10 ml was taken and mixed with 0.1% sterile peptone water. Nutrient agar(Himedia – India). solid culture medium was used (Himedia – India).

The dishes were incubated after planting, casting and solidification in the incubator at $35^\circ C$ for a period of (24 – 48) hours (12). As well the total numbers of coliform and fecal coliform (E. coli) were estimated by using the most probable number (MPN) where it was used three tubes for each dilution and each tube containing a Durham tube inside it by using MacConkey Broth (Oxoid -UK) culture medium. The results based on tables of the cultured dilutions of (1 , 0.1 , 0.01) ml and the results were observed through formation of acid and gas

after incubation at 37°C for total coliform bacteria, and at a temperature of 44.5°C for (24 – 48) hours for fecal coliform bacteria (E. coli) (13). Fungi (yeasts and molds) were estimated by using the dish casting method where using potato dextrose agar (Himedia- India) and then incubated at 25°C for (3 – 4) days (14). As for the physicochemical tests they included the estimation of total dissolved solids (TDS) , pH , and Electrical Conductivity (EC) (13) .

Statistical analysis was conducted using SPSS v19 program to find out the correlation coefficient (r) between each of the total number of bacteria, total coliform bacteria, fecal coliform bacteria and the total number of yeasts and molds as well as between the studied microbial indicators with the residence time of water in silver utensils (15).

Results and Discussion

Table (1) shows the results of the microbial examination for the total number of bacteria, yeasts, and fungi, **Total bacteria count:** their numbers were decreasing with the increase the residence time of the water in the silver utensils, and the highest percentage of decrease was recorded in the first ten minutes where their numbers reached 80(cfu / 100 ml) (Colony Forming Unit) after 60 minutes. This number is very small and acceptable for use. **Yeasts:** The number of yeasts was decreasing with the increase in the residence time of the water in the silver utensils, and they were completely eliminated in the first ten minutes. **Molds:** The number of fungi recorded decreasing with the increase the residence time in the silver utensils, and they were completely eradicated in 15 minutes. Whereas table (2) shows the results of the microbial examination of the total coliform and fecal coliform bacteria.

Table (1) Results of Microbial test for total Bacterial count , Yeast and Mold.

Parameter / Retention time (min)	Yeast/100ml	Mold/100ml	Total bacterial count Bacteria (cfu /100ml)
Raw water (0)	3	20	35000
10	0	10	1700
15	0	0	1300

30	0	0	250
45	0	0	120
60	0	0	80

The total coliform bacteria : their numbers started decreasing with the increase the residence time ,and the largest decrease was recorded in the first 15 minutes .Bacteria decreased significantly in the 45th minute , but it expired at the 60th minute and therefore water at 60th minute is considered safe to drink conforming to the specifications of drinking water according to the world health organization (WHO) and the United State Environmental Protection Agency (EPA) which requires that the water be free of coliform bacteria for every 100 ml. (16,17).

Fecal coliform bacteria (E. coli): Their numbers began to decrease with the increase the residence time and the largest decrease was recorded in the first (15) minutes. Bacteria decreased significantly in the 45th minute, but ended in the 60th minute and therefore water at 60th minute is considered safe to drink according to the world health organization (WHO) and US environmental protection agency (EPA) which requires that water should be free of coliform bacteria (fecal) per 100 ml. (16,17)

Table (2) Results of the microbial test for total coliform and fecal coliform bacteria.

Parameter / Retention time (min)	Probable Number of bacteria at $37C^0$ (Coliform/100ml)						Probable Number of bacteria at $44.5C^0$ (Ecoli/100ml)					
	Combination of positives			MPN index /g	95% Confidence limits		Combination of positives			MPN index /g	95% Confidence limits	
	10	10^{-1}	10^{-2}		Lower	Upper	10	10^{-1}	10^{-2}		Lower	Upper
Raw water (0)	3	3	3	>110	>15	>480	3	3	3	>110	>15	>480
10	3	3	2	110	15	480	3	2	0	9.3	1.5	38
15	3	2	2	21	3.5	47	2	2	1	2.8	1.0	15
30	3	1	0	4.3	0.7	21	2	2	0	2.1	0.4	4.7
45	2	2	1	2.8	1.0	15	2	1	0	1.5	0.3	4.4
60	1	1	0	0.7	0.1	2.3	1	0	0	0.4	<0.05	2

It is clear from table (3) which represents the multiple correlation between the microbial parameters of the study where the correlation coefficient was direct and strong between the microbial parameters (biological parameters) with each other as it ranged between (0.878 – 0.999) and the correlation was significant between the variables with each other on the level (0.05) . As for the correlation between the residence time and the microbial parameters it was inversely related and ranged between (- 0.575 to - 0.753) with no significant

differences recorded between the residence time and the microbial parameters at the level (0.05).

Table (3)   Multiple Correlation between microbial indicators of the study

Parameter	Statistical analysis	Yeast	Mold	T. count bacteria	T. coliform	E-coli	Time
Yeast	**Correlation**	**1**					
	Sig. (2Tailed)						
Mold	**Correlation**	**0.878**[*]	**1**				
	Sig. (2Tailed)	**.021**					
T. count bacteria	**Correlation**	**.999**[*]	**.895**[*]	**1**			
	Sig. (2Tailed)	**.000**	**.016**				
T. coliform	**Correlation**	**.921**[*]	**.992**[*]	**.936**[*]	**1**		
	Sig. (2Tailed)	**.009**	**.000**	**.006**			
E-coli	**Correlation**	**.999**[*]	**.898**[*]	**1.00**[*]	**.937**[*]	**1**	
	Sig. (2Tailed)	**.000**	**.015**	**.000**	**.006**		
Time	**Correlation**	**-.575**	**-.736**	**-.609**	**-.753**	**-.602**	**1**
	Sig. (2Tailed)	**.233**	**.095**	**.199**	**.084**	**-.206**	

*   : correlation is significant at the 0.05 level (2- tailed).

Table (4) shows the results of physiochemical parameters for water reserving in silver utensils. **Total Dissolved Solids (TDS) :** This parameter did not change during the period of residence of the water in the silver utensils and it remained in the range of (2268 – 2292) mg / l which is higher than the limits of the specifications of the world health organization and the US environmental protection agency for drinking water which does not permit the use of drinking water if it exceeds (1000 mg / l). (16,17) Table (4) demonstrates the results of the physicochemical properties of water preserved in silver utensils . **Electrical conductivity (EC) :** The value of this parameter remained constant and did not change with the change of residence time is silver utensils and it ranged between (4.59 – 4.62) ds /m. **pH:** This criterion remained constant throughout the residence time of the water in the silver utensils where it ranged between (7.57 – 7.61) and it is within the limits of the specifications of the world health organization (WHO) and the US environmental protection agency (EPA) for drinking water which is between (6.5 – 8.5). (16,17)

Table (4) Results of physiochemical parameters for water reserving in silver utensils.

Parameter	Silver utensils			
Retention time (min)	TDS (mg/l)	Ec ds/m	pH	T ^{0}C
Raw water (0)	2292	4.62	7.61	13.3
10	2277	4.60	7.57	18
15	2268	4.59	7.59	19
30	2277	4.60	7.59	21

45	**2277**	**4.60**	**5.60**	**22**
60	**2292**	**4.62**	**7.61**	**23.01**

Conclusions

The largest percentage of eradication of total coliform and fecal coliform bacteria was at a residence time of (15) minutes in silver utensils while the largest percentage of eradication of total bacteria, yeasts and molds was at a residence time of (10) minutes. The results demonstrate that all the microbial pathogenic contaminants were eliminated at (60) minutes and only acceptable numbers of total bacteria were left .4. The results showed that keeping water in silver utensils did not affect or change the quality of the physicochemical properties of the studied water which are (TDS , EC , pH).

Recommendations

We recommend the use of silver utensils in the absence of known sterilization methods(or physical, chemical) (8) to reach an acceptable condition from a microbial and physicochemical point of view and the validity of the water for use for domestic purposes. It is recorded to check other biological parameters as well as use more polluted water samples with the required residence time.

References

1. UN:United Nations (2003), Water scarcity in the Arab world, population and development report, economic and social commission for Western Asia, No. 1, New York.40 p.

2. WWAP: World Water Assessment Programme (2017). The United Nations world water development report: Wastewater, the untapped resource, Paris. United Nations Educational, Scientific and Cultural Organization.

3. Nath, K.J.; Bloomfield, S. and Jones, M. (2006). Household water storage handing and point of use treatment. International Scientific Forum on Home Hygiene (IFH). USA.

4. Al-Tomei, A.S. and Saad, M.A. (2008). Bacteriology of drinking water. Biotechnic Research Center.

5. AL-Nuaaman. A. and Al- Ballo. M. (2019). Detection of bacterial contamination of drinking water in the right side of Mosul city by multiple tubes fermentation technique. Journal of Education and Science, 28(2): 167 -184. DOI: 10.33899/edusj.2019.161185.

6. Al-Muslhi, M. H. (2007). Construction engineering for water and sanitation facilities. Scientific Books House for Publishing and Distribution, Cairo, Egypt.895 p.

7. Hajjar, S. (2006). Drinking water treatment. Directorate of University Books and Publications, Halab, Syria.477 p.

8. WHO: World Health Organization (2004). Handbook for emergency disinfection of drinking water, Regional Office for Environmental Health Activities, Amman.21 p.

9. Skipton, S.O.; Dvorak, B.I.; Woldt, W.E. and Wirth, S.L. (2014). Drinking water: bacteria. Institute of Agriculture and Natural Resources, Lincoln Extension, University of Nebraska.

10. WSDH: Washington State Department of Health (2016). Coliform bacteria and drinking water. Washington State Department of Health, Division of Environmental Health, Office of Drinking Water.

11. WDONR: Wisconsin Department of Natural Resources (2017). Bacteriological contamination of drinking water wells. Wisconsin Department of Natural Resources , Bureau of drinking water and ground water. Washington, D.C.

12. Andrews, W. (1997), Manual of food quality control. 4. Rev. 1. Microbiological analysis. FAO Food and Nutrition Paper No. 14/4 (Rev. 1)., Rome, Italy . 347 p.

13. APHA: American Public Health Association (2017). Standard methods for the examination of water and wastewater. 23th Edition, American Public Health Association, American Water Works Association, Water Environment Federation, Washington, DC.

14. Cappuccino, J. G. and Welsh, C. (2019), Microbiology a Laboratory manual, 12th Edition, Pearson Publisher, New York,541p.

15. Amin, O. R. (2008). Statistical analysis of multiple variables using SPSS program. Department of Statistics and Mathematics, Faculty of Commerce, Menoufia University.199 p.

16. WHO: World Health Organization (1996). Guidelines for drinking-water quality. Vol. 2, Health criteria and other supporting information. 2nd ed., Geneva.330p.
https://apps.who.int/iris/handle/10665/38551

17. EPA: Environmental Protection Agency (1989). Drinking water; national primary drinking water regulation; total coliforms (Including faecal coliforms and *E. coli*);Final Rule, part 3,pp:27544-27568.