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The Effect of Different Types of Storage Vessels on Water Quality

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ABSTRACT: The method of storage is essential in maintaining water purity and safety for drinking purposes. The present study attempts to investigate the effect of different types of storage vessels such as plastic, glass, brass, copper, aluminium, steel and clay on water quality. The physico-chemical and biological parameters of initial water and after storing the water in different vessels for 30 days were analysed. Results obtained in this study reveals that quality of water stored in clay pot, brass and copper is better than others.

KEYWORDS: Storage vessels, water quality, biological parameters and physico-chemical parameters, antibacterial activity

I. INTRODUCTION

Water intended for human consumption must be safe and free from microbes. Access to safe drinking water has improved over the last decades in almost every part of the world, but approximately one billion people still lack access to safe water and over 2.5 billion lack access to adequate sanitation (Kulshreshtha, 1998)[1]. Diseases related to contamination of drinking water constitute a major burden on human health. It is estimated that approximately 780 million people lack access to an improved water source. In India, there are additional problems due to the disruption of piped water supplies in rural and urban areas, resulting in a need to store water for drinking, food preparation and bathing purposes. Drinking water may be contaminated at the source or during storage. Even though, storage of water has been recommended as method of water purification, contamination of treated or disinfected water can also occur during storage due to improper handling. Hence it is important from a safety point of view to maintain the quality of drinking water during storage (Prescott *et al.* 1999)[2]. The Indian Ayurveda describes storing water in a copper vessel overnight and drinking it in the mornings for many health benefits. Copper is known for its antimicrobial, anti-inflammatory, antioxidant and anticarcinogenic activities. For centuries, storing water in brass vessels has also been said to be good for health. It is believed that the zinc and copper present in the brass boost immunity and protect against illness. For generations, earthen pots have been used to store water which keeps water clean and clear. Now a days people are using containers made of plastic, steel etc, to store water. The fact is these substances do not possess any antibacterial and purification properties. Now a days, the use of conventional storage vessels like copper and clay pots are declining. People tend to depend on modern techniques and procedures regarding water purification instead of easy and affordable conventional techniques (Chauhan and Paliwal, 2009)[3]. Therefore the present study intended to determine the effect of different storage vessels on the purity of water and thereby protect and promote the human health.

II. REVIEW OF LITERATURE

Packiyam *et al.*, (2016)[4] conducted studies on “the Effect of Storage Containers on Coliforms in Household Drinking Water” which revealed that there was no significant reduction of coliform bacteria in the water stored in Glass, Plastic, Ceramics, Coconut shell, Aluminium and Stainless Steel container, where as significant level of reduction of coliforms bacteria was observed in the water stored in Mud pot, Brass, Copper and Silver containers suggesting that water can be stored in any one of these containers for house hold purpose free from microbes. Radha

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and Susheela (2015)[5] carried out a comparative microbiological analysis of water stored in different storage vessels. The effect of storage of lake water in different vessels like plastic, clay, copper and stainless steel was studied by comparing the number of coliforms present in the water before and after storage. The findings may have significant implications in the use of vessels made of copper and its alloys for household storage of drinking water. Akuffo *et al.*, (2013)[6] carried out an assessment of the quality of water before and after storage in the Nyankpala Community of the Tolo -Kumbungu District, Ghana. Colour, turbidity and total iron levels recorded in stored water in metallic containers were higher than WHO guidelines for portability. Though tap water recorded no coliform bacteria during the study period, stored water analysed from all storage facilities recorded coliform bacteria. The presence of coliform bacteria in stored water probably resulted from unhygienic water-handling practices. Water stored in earthen pots recorded the lowest level of coliform bacteria. Water stored in PC recorded the highest levels of coliform bacteria during the study period. EP storage facilities recorded lower coliform levels because they have narrow nozzles which make access to water more difficult compared to that of PC and MC which has wide openings at the top. Douhri *et al.*, (2015)[7] conducted studies on “the effect of house storage on water’s quality in rural areas of Tangier-Tetuan Region (Morocco)”. The result revealed that there was a significant difference between the numbers of microorganisms initially present in the water and those present after storage for 15 days at ambient temperature. There was a significant difference between chemical parameters initially measured in the water and those measured after storage for 15 days at ambient temperature. Trevett *et al.*, (2005)[8] studied about “the importance of domestic water quality management in the context of faecal–oral disease transmission”. It is shown that considerable evidence of disease transmission from re-contaminated drinking water exists. In particular the type of storage container and hand contact with stored drinking water has been associated with increased incidence of diarrhoeal disease. There is also circumstantial evidence linking such factors as the sanitary conditions in the domestic environment, cultural norms and poverty with the pathogen load of household stored drinking water and hence the risk of disease transmission.

III. MATERIALS AND METHODS

In the present study the Effect of different storage vessel on water quality was analysed. Water was collected from Meenachil River and stored in different types of vessels (aluminium, steel, copper, brass, clay pot, glass and plastic) for 30 days. The physical parameters like temperature, Total Dissolved Solids and Electrical Conductivity and chemical parameters like pH, Salinity, Alkalinity, Hardness, DO, BOD, COD, Copper and biological parameters like Total Colony Count, Total Coliform were analysed according to the methods of APHA 1998[9].

3.1. WATER QUALITY INDEX

The integrated status of various water quality parameters that are relevant and significant to particular use is reflected in WQI. Water quality index provides a single number (like a grade) that expresses overall water quality at certain location and time. WQI is calculated by the method suggested by Tiwari and Mishra (1985)[10].

$$WQI = \sum W_i \times V_r$$

Where, $W_i \propto 1/V_i$ or $W_i = k/V_i$

k = constant of proportionality

W_i = Unit weight of factor

V_i = maximum permissible limits as recommended by Indian Council of Medical Research / Public health Environmental engineering Organization.

Value of k is calculated as:

$$k = \frac{1}{\sum 1/V_i}$$

The Water Quality Index is the sum of the product of rating (V_r) and unit weight (W_i) of all the factors.

i.e. $WQI = W_{i(pH)} \times V_{r(pH)} + W_{i(EC)} \times V_{r(EC)} + W_{i(TDS)} \times V_{r(TDS)} + W_{i(Alkalinity)} \times V_{r(Alkalinity)} + W_{i(Hardness)} \times V_{r(Hardness)} + W_{i(DO)} \times V_{r(DO)} + W_{i(BOD)} \times V_{r(BOD)} + W_{i(COD)} \times V_{r(COD)}$

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WQI ranges are given in the table 1

Table 1: WQI Ranges

Value of WQI	Quality of water
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very Bad

IV. RESULT AND DISCUSSION

The physical, chemical and biological parameters of water stored in different types of vessels were evaluated and the results of physico-chemical parameters are shown in table 2. The study revealed that, the quality of water varies in different types of vessels.

Among the physical parameters temperature ranges between 28.7°C to 30.7°C. Temperature of initial water is 30.7°C. Temperature is low for water stored in clay pot < aluminium < copper < glass. Trevett *et al.*, (2004)[12] studied Water Quality Deterioration: A Study Of Household Drinking Water Quality In Rural Honduras and it revealed that clay storage containers maintained low water temperature than other containers as a result of evaporation through the porous material. Electrical conductivity is a measure of how well water can pass an electric current and is an indirect measure of inorganic dissolved solids. It helps in determining suitability of water for irrigation and domestic uses. In the present study EC value ranges between 117.3-154.8 micro ohms. EC of initial water is 127.6 micro ohms. High EC (154.8) value is shown by water stored in copper vessel while low EC (117.3) is shown by water stored in aluminium vessel. TDS helps in understanding the level of turbidity and hardness of water. TDS of initial water is 90.6 mg/L. High TDS value is obtained for the water stored in copper vessel (108 mg/L) and clay pot (115 mg/L) and low TDS is shown by water in aluminium vessel (65mg/L). Desirable TDS value of drinking water is 300 mg/L. pH of stored water ranges between 7.34 and 13. High pH is observed for water stored in glass (9.8), aluminium vessels (10.5) and steel (10). Water stored in clay pot (7.45) and copper vessels (7.34) have low pH value. Water with pH value more than 9 or less than 4.5 become unsuitable for most life forms and also for other uses. The desirable pH range of drinking water is 6.5-8.5.

Alkalinity of water stored in different vessels range from 50 mg/L-125 mg/L. In the present study high alkalinity is shown by water stored in vessels made up of aluminium and copper (125 mg/L). Low alkalinity is observed for water stored in plastic container (50 mg/L). It is observed that alkalinity of water increases on storage. Salinity of stored water varies between 60.6ppm to 76.1ppm. Lowest salinity is found in water stored in aluminium vessel (60.6 ppm) and the highest salinity for water stored in copper vessel (76.1 ppm). In the present study hardness ranges between 75 to 145 mg/L. Highest value for hardness is observed for water stored in copper (145 mg/L) and brass vessel (140 mg/L). While water stored in aluminium (75 mg/L) have low hardness. DO levels of stored water ranges between 5.2 to 6.4 mg/L. DO value is highest for water stored in brass (6.4 mg/L), clay and copper vessel (6 mg/L). Water kept in steel show low DO level (3.2 mg/L). BOD refers to the amount of oxygen used by microorganisms in the aerobic oxidation of organic matter. Water is considered pure with BOD of 3mg O₂/L. In the present study BOD value ranges between 0.4 to 3 mgO₂/ L. Low BOD level is found in water stored in copper and glass vessel (0.4 mg/L) whereas high BOD is found in the water stored in aluminium and plastic vessels (4 mg/L). COD value of stored water ranges between 1.6 to 4.8 mg/L. Highest COD value is obtained for water stored in plastic and steel (4.8 mg/L) containers while lowest COD value is shown by water stored in clay pot (1.6 mg/L). Copper is one of the most abundant trace elements. It is an essential micronutrient for almost all organisms. Copper content is high in water stored in copper (0.0575 mg/L) and brass vessel (0.015 mg/L) and low copper content for water stored in plastic and glass vessel (0.005 mg/L).

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Table 2: Values obtained for physical and chemical parameters

TYPESOF VESSEL	INITIAL	ALUMINIUM	CLAY POT	BRASS	COPPER	PLASTIC	STEEL	GLASS
PHYSICAL PARAMETERS								
Temperature	30.7	29.7	28.7	30.3	29.9	30.3	30.3	30.1
Electrical conductivity	127.6	117.3	128.5	126.8	154.8	122.5	125.7	126.9
TDS	90.6	65	115	99	108	40	60	70
CHEMICAL PARAMETERS								
pH	7.8	10.5	7.45	7.39	7.34	13	10	9.8
Salinity (ppm)	64.1	60.6	63.9	64.5	76.1	62.7	63.5	63.6
Alkalinity(mg/L)	50	125	75	100	125	50	75	75
Hardness (mg/L)	75	75	95	140	145	60	90	90
DO (mg/L)	6	5.6	6	6.4	6	4	3.2	5.6
BOD (mg/L)	0.48	4	0.8	0.8	0.4	3	0.8	0.4
COD (mg/L)	4.8	3.2	1.6	3.2	3.2	4.8	4.8	3.2
Copper (mg/L)	0.005	0.0075	0.001	0.015	0.0575	0.005	0.0075	0.005

WATER QUALITY INDEX

Water Quality Index is high for water stored in clay pot, Brass and copper vessel with values 88.82, 88.49 and 88.39 respectively. Quality of water with WQI value between 70 and 90 is considered as good. Therefore quality of water stored in clay pot, brass and copper is good than water stored in other vessels. WQI of initial water and water stored in glass vessel is 62.96 and 69.56 respectively. WQI value between 50 and 70 is considered as medium. So the quality of initial water, water stored in glass, Aluminium and Steel vessels are medium. The WQI for water stored in Plastic bottle comes under the category of Bad water quality.

Table 3: Water Quality Index of water stored in different types of vessels

TYPE OF WATER STORAGE VESSEL	WQI	QUALITY
Aluminium	55.00	Medium
Clay pot	88.82	Good
Brass	88.49	Good
Copper	88.39	Good
Plastic	48	Bad
Steel	69	Medium
Glass	69.56	Medium
Initial	62.96	Medium

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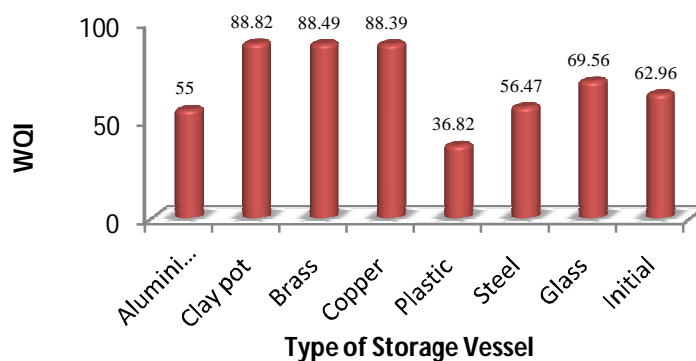


Fig1. WQI of water in different storage vessels

MICROBIOLOGICAL OBSERVATION

Total Heterotrophic Bacterial count is a method which determines colony formation in culture media of heterotrophic bacteria in drinking water. It can also be used to measure the overall bacteriological quality of drinking water in public, semi-public and private water systems. Microbial examination revealed that THB took the order of Glass > steel > aluminium > plastic > initial water > brass > copper > clay. From the MPN index, Coliform bacteria took the order of glass > plastic, steel > copper, aluminium, clay > brass. Packiyam *et al.* (2016)[11] conducted studies on Effect of Storage Containers on Coliforms in Household Drinking Water. The results revealed that there was no significant reduction of coliform bacteria in the water stored in Glass, Plastic, Ceramics, Coconut shell, Aluminum and Stainless Steel container, where as significant level of reduction of coliforms bacteria was observed in the water stored in Mud pot, Brass, Copper and Silver containers suggesting that conventional water storage vessels such as copper, brass and clay possessed antimicrobial activity and are highly efficient against pathogenic bacteria than vessels made up of plastic, steel, aluminium, etc. Therefore, they are most suitable containers to store water.

THB COUNT OF WATER IN DIFFERENT STORAGE VESSELS



Fig 1. Initial water



Fig 2. Aluminium Vessel



Fig 3. Copper vessel



Fig 4. Plastic bottle



Fig 5. Clay plot

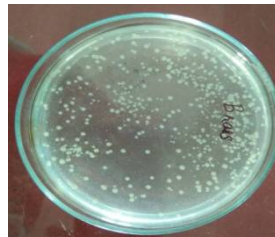


Fig 6. Brass vessel



Fig 7. Steel vessel



Fig 8. Glass vessel

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Table 4: Total Heterotrophic Bacterial count

Sl. No.	Type of vessel	Bacterial count (CFU/mL)
1	Aluminium	294
2	Clay pot	56
3	Brass	201
4	Copper	103
5	Plastic	269
6	Steel	300
7	Glass	395
	Initial	220

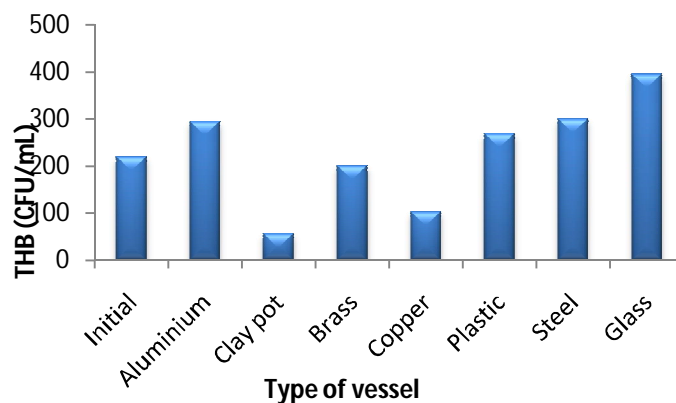


Fig 2. Total heterotrophic bacteria of water in different vessels

Table 5: Determination of bacterial growth using MPN method

Sample no.	Vessel	No. of tubes giving positive reaction out of			MPN Index/100 ml
		3 of 10 ml each	3 of 1 ml each	3 of 0.1ml each	
1	Aluminium	1	3	0	110
2	Clay pot	1	2	1	110
3	Brass	2	2	1	28
4	Copper	1	2	1	110
5	Plastic	3	2	2	210
6	Steel	3	2	2	210
7	Glass	3	3	3	11000
	Initial	3	3	3	4600

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V. CONCLUSION

The present study ends with the point, conventional water storage vessels such as copper, brass and clay possessed antimicrobial activity and highly efficient against pathogenic bacteria than vessels made up of plastic, steel, aluminium, etc. Conventional water storage systems are not expensive but in fact very effective. They are not like the complex and expensive water purifying methods. The most important thing is that, it is available to everybody, even in people from rural areas. Therefore, they are most suitable containers to store water.

REFERENCES

- [1] Kulshreshtha, S.N. (1998). A Global Outlook for Water Resources to the Year 2025. *Water Resources Management*, 12(3): 167-184.
- [2] Prescott, L.M., Harley, J.P. and Klein, D.A. (1999). *Water Microbiology*, McGraw-Hill Co. Inc., New York. 876-882.
- [3] Chauhan, PKS. and Paliwal, R. K. (2009). Study of seasonal variation of heavy metal concentration in bed sediments of Yamuna river. *Current World Environment*, 4(2): 439-442.
- [4] Packiyam, R., Kananan, S., Pachaiyappan, S. and Narayanan, U. (2016). Effect of Storage Containers on Coliforms in Household Drinking Water. *International journal of Current Microbiology and Applied Science*, 5(1): 461-477.
- [5] Radha, R and Susheela, P. (2015). Comparative microbiological analysis of water stored in different storage vessels. *International journal of pharma and bio sciences*, 6(2): 121 – 128.
- [6] Akuffo, I., Cobbina, S.J., Alhassan, E.H. and Nkoom, M. (2013). Assessment of the quality of water before and after storage in the Nyankpala community of the Tolon- Kumbungu District, Ghana. *International journal of scientific & technology research*, 2(2) : 270-289.
- [7] Douhri H., Raissouni I., Tazi S. and Douhri B. (2015). Effect of house storage on water's quality in rural areas of Tangier-Tetuan region. *Larhyss Journal*, 24: 301-314.
- [8] Trevett, A. F., Carter, R. C. and Tyrrel, S. F. (2005). The importance of domestic water quality management in the context of faecal-oral disease transmission. *Journal of water and health*, 3(2): 259-264.
- [9] APHA, AWWA & WEF (1998). *Standard methods for the examination of water and wastewater*, 20th edition. Clesceri, L.S. Greenberg, A.E. and Eaton, A.D. (Eds.), American Public Health Association, American Water Work Association, Water Environment Federation, Washington DC.
- [10] Tiwari, T.N & Mishra, M. (1985). A preliminary assignment of water quality index to major rivers. *Indian Journal of Environmental Protection*, 5: 276-279.
- [11] Packiyam, R., Kananan, S., Pachaiyappan, S. and Narayanan, U. (2016). Effect of Storage Containers on Coliforms in Household Drinking Water. *International journal of Current Microbiology and Applied Science*, 5(1): 461-477.
- [12] Trevett, A. F., Carter, R. C. and Tyrrel, S. F. (2004). Water Quality Deterioration: A Study Of Household Drinking Water Quality In Rural Honduras. *International Journal Of Environmental Health Research*, 14(4): 273-283.