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Comparative Study on Purification of Drinking Water Stored in Copper and Brass Vessels to Prevent Waterborne Diseases

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Abstract

A safe and convenient source of drinking water is of paramount importance to human health. A huge population in developing countries lives in rural areas. The people believe that traditional use of copper/brass vessels for storing drinking water offers some protection against sickness. In the present paper, a comparative study was undertaken to evaluate the effect of storage of water samples in copper and brass vessels, against the indicator microorganism, *E. coli*. The drinking water samples collected from different sources were stored in copper and brass vessels for 24-48hrs and after every 6hr samples were withdrawn from the stored water, for the enumeration of Total coliforms and fecal coliforms by MTFT and MFT. Coli form count was determined, on storage for different time intervals, in copper & brass vessels. It was observed that the amount of *E. coli* in the copper vessels dropped dramatically over time, and fell to undetectable levels in 18-24 & storing water samples in brass vessels killed the indicator *E. coli*, within 30-36hrs, thus making water safe for consumption from microbiological perceptive. The findings of the present study have important implications in relation to the practical use of copper vessels in rural areas of India and elsewhere.

Keywords: *E. coli*; Copper vessel; Brass vessel; Drinking water; Water purified

Introduction

Around 37.7 million Indians are affected by waterborne diseases annually, 1.5 million children are estimated to die of diarrhea alone and 73 million working days are lost due to waterborne disease each year. The major pathogenic organisms responsible for water borne diseases in India are bacteria (*E. Coli, Shigella, V. cholera*), viruses (*Hepatitis A, Polio Virus, Rota Virus*) and parasites (*E. histolytica, Giardia, Hook worm*). Studies carried in rural south India and Rajasthan have highlighted the importance of these facts [1]. However, a major source of enteric infections in developing nations is due to water contamination during household storage [2]. Ensuring the microbial safety of drinking water depends on the presence or absence of *E. coli* as an indicator of contamination of water [3,4]. The water should be free from *E. coli* for making the drinking water safe; many strategies have been practiced successfully for years. Consequently, it is important to develop and implement small-scale point-of-use water disinfection methods that can be used to improve water quality at the household level in India and other developing countries. The World Health Organization has established a network to promote such activities [5].

It has been reported that copper can inactivate harmful water borne microorganisms, including *L. pneumophila*, the principal agent of Legionnaire's disease, methicillin-resistant *Staphylococcus aureus*, *E. coli* (a food and waterborne bacterium that causes severe illness and death) and *Listeria monocytogenes* [6,7]. It has been reported recently that when water samples are stored in copper vessels kill the enteric bacteria *S. typhae* & *V. cholera* [8-10]. In the developing countries such as India, since ages we are using the copper and brass pots traditionally to store the drinking water. Hence in the present study the impact of storing water samples in copper and brass vessels was studied on the coliform count. Drinking water samples collected from different sources were stored in copper and brass vessels for 24-48 hrs & the reduction in total viable count of indicator microorganism *E. coli* was detected by MTFT and MFT.

Materials and Methods

Collection of water samples

Drinking water samples were collected from different well water sources in rural areas of Nagpur, in pre-sterilized glass bottles. A total of three well water samples were collected and the effect of storage in copper and brass vessels on total and fecal coliform count by MTFT and MFT was studied.

Storage of drinking water samples: Water samples thus collected, were stored in copper and brass vessels separately for 24-48hrs at room temperature.

Determination of coliform count: After bringing the samples to the laboratory, the samples were immediately analyzed for total and fecal coliform, to determine the coliform count at 0 hr by MTFT and MFT. At every six hours up to 48hrs. The water samples were withdrawn from the vessels for determination of total and fecal coliforms and the effect of storage of drinking water samples for different time intervals in copper & brass vessels was studied. The coliforms were detected as per the APHA standard methods for water and wastewater analysis.

Results and Discussion

The present study was undertaken to evaluate the ancient method of storing drinking water in copper/brass vessel for their effectiveness in removing the coliform bacteria. The experiments were performed with well water samples from rural areas. The samples were stored in copper & brass vessels for different time intervals & samples withdrawn every 6 hour for detection of coliform by MTFT & MFT techniques. The results of MPN technique performed for water samples 1, 2, 3 stored in copper vessel and brass vessel are reported in Table 1 & Figure 1. The results of confirmed test performed for water samples are shown in Table 2, which confirmed the presence of coliforms in all the water samples tested and after 18-24 hours the test was negative for the samples stored in copper vessel & after 42 hours in case of brass vessel. The enumeration of coliform was also done by MFT for water samples stored in copper & brass vessels, effect on the Total coliform count shown in Table 3 and on fecal coliform count in Table 4 & Figure 2. Initially at 0hr, where the count was TNC (too numerous to count), it fell down to 0 in 18-24 hours in copper vessel and beyond 30-36 hours in brass vessel. The findings in the present study indicates that the dirking water sample collected from the wells in rural areas were highly contaminated and not good for consumption without treatment. The study also indicates that when these water samples were stored in copper and brass vessels, the viable count of *E. coli* in copper vessel dropped over time, and after 18-24 hours they fell to undetectable levels in all the three samples tested, while in brass vessels it took 30-36hrs to drop to undetectable limits. The P^H of the water samples was in the range of 7.4 ± 0.4. Even though copper and brass both were effective in reducing the coliform count, storage of water in copper vessel was found to be more effective as it reduced the coliform to undetectable levels within a short span of time.

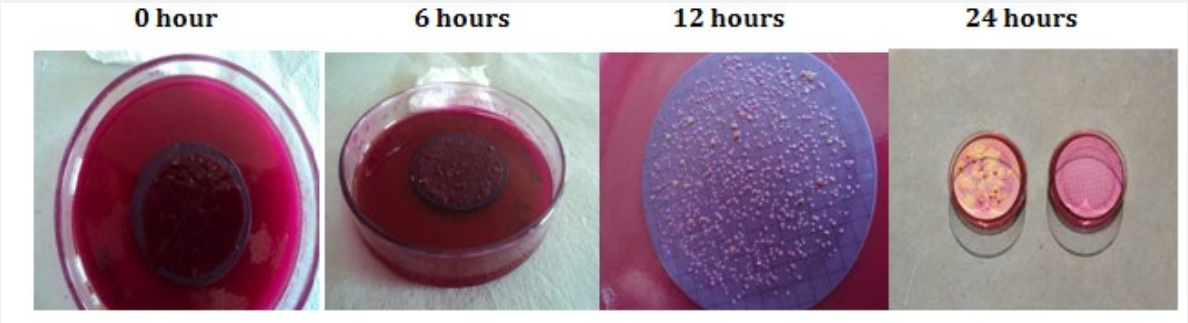

Figure 1: Total coliform count by MFT for water samples stored in Copper and Brass vessels on M-Endo agar plates.

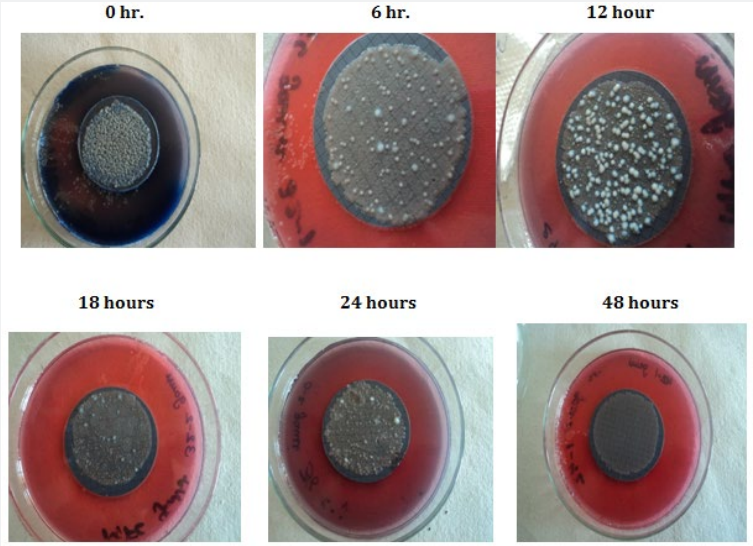

Figure 2: Fecal Coliform count by membrane filtration technique for water samples stored in Copper and Brass vessels on M-FC Agar plates.

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Table 1: Coliforms from MTFT in drinking water sample stored in copper vessel and brass vessels.

Time of Storage of	Copper Vessel			Brass Vessel		
Water Sample	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
0hr	2400	1100	2400	2400	2400	1100
6hrs	1100	1500	210	1100	1100	210
12hrs	150	20	39	150	210	20
18hrs	4	4	23	28	28	24
24hrs	0	0	0	11	14	10
30hrs	0	0	0	4	5	5
36hrs	0	0	0	0	0	0
42hrs	0	0	0	0	0	0
48hrs	0	0	0	0	0	0

** All values are CFU/100ml of water sample calculated from MPN chart.

Table 2: Confirmed test for coliforms in drinking water sample stored in copper vessel and Brass vessel.

Time	Confirmed Test for Water Stored in Copper Vessel			Confirmed Test for Water Stored in Brass Vessel		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample3
0 hour	+	+	+	+	+	+
6 hours	+	+	+	+	+	+
12 hours	+	+	+	+	+	+
18 hours	+	+	-	+	+	+
24 hours	-	-	-	+	+	+
30 hours	-	-	-	+	+	+
36 hours	-	-	-	+	+	-
42 hours	-	-	-	-	-	-
48 hours	-	-	-	-	-	-

+ = Positive confirmed test, - = Negative confirmed test

Table 3: Total coliform count by MFT for water samples stored in Copper and Brass.

Time	Number of Colonies per 100ml of Sample					
	Result for Copper Vessel			Result for Brass Vessel		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
0 hour	TNC	TNC	TNC	TNC	TNC	TNC
6 hours	400	335	270	389	333	271
12 hours	114	118	105	100	200	117
18 hours	31	55	42	20	90	43
24 hours	1	4	3	11	41	28
30 hours	0	0	0	3	28	8
36 hours	0	0	0	0	6	1
42 hours	0	0	0	0	0	0
48 hours	0	0	0	0	0	0

Vessels on M-Endo agar plates.

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Table 4: Fecal Coliform count by Membrane Filtration Technique for water samples. Stored in Copper and Brass vessels on M-FC Agar plates.

Time of Storage of Water Samples	Results for Copper Vessel			Results for Brass Vessel		
	Number of Colonies per 100ml of Sample					
	Total Coliforms			Total Coliforms		
	Sample 1	Sample 2	Sample 3	Sample 1	Sample 2	Sample 3
0 hour	TNC	TNC	TNC	TNC	TNC	TNC
6 hours	89	102	111	225	304	280
12 hours	76	72	63	180	274	212
18 hours	22	23	9	95	118	103
24 hours	0	0	0	67	83	78
30 hours	0	0	0	34	41	38
36 hours	0	0	0	4	3	3
42 hours	0	0	0	0	0	0
48 hours	0	0	0	0	0	0

It was also evident from the results that in both copper as well as brass vessels the number of fecal coliforms was also reduced to undetectable levels in 18-24hrs and 30-36hrs respectively. Although the effect of ambient temperature was not studied here, it's important to study the time required to inactivate the coliforms on storage of water at different temperatures. Studies have shown the merits of copper surfaces for their use in improving public hygiene in healthcare facilities, the potential use of copper for the purification of drinking-water, especially in developing countries, has not been widely studied. Therefore, results of our study indicate that copper holds potential to provide microbiologically-safe drinking-water to the rural masses in developing countries. The use of copper and brass pots in Indian households is common and is, therefore, likely to be socially accepted by the people. Its functioning is not dependent on fuel, electricity, replaceable filters, intensity of sunlight, etc to operate or maintain it; it is simply a passive storage of water. This takes into account the conditions prevailing in rural villages and the urban slums of developing countries. The health benefit that can be achieved by using copper pot as a PoU water-purification device will far outweigh the cost of the pot, if divided over the members in a rural family, especially as it will be a one-time investment with no recurring costs.

Conclusion

Water disinfection is very much essential to reduce/or kill the water borne pathogens. Mainly in the developing countries such as India, as we are using the copper and brass pots traditionally to store the drinking water, which were found to be effective against the water borne pathogens, as also reported earlier [11]. This present investigation also proved that the storage of water in copper and brass vessels can diminish the water borne pathogens and can be used to store the water safely, as also substantiated by other workers [12,13]. The findings of the present study have important implications in relation to the practical use of copper and brass vessels in rural areas of India and elsewhere. This approach empowers households and communities that lack potable water to protect themselves against a variety of waterborne pathogens and has the potential to decrease the incidence of waterborne diarrheal disease.

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