Research Article

Household drinking water: Assessment of microbiological contamination between source and point of use

Tambekar DH, Dhote SV and Shinde GM

Post Graduate Department of Microbiology, Sant Gadge Baba Amravati University,
Amravati, 444602 (India)
Email: diliptambekar@rediffmail.com

Article Info	Abstract
	Microbial contamination of drinking water has the potential to cause large outbreaks of waterborne diseases. This study is carried out to find the association of socioeconomic status, water storage and handling practices, hygienic condition of the house and surrounding and awareness about the waterborne diseases on household drinking water. Total 200 samples (fresh and residual water) of household drinking water were collected from 200 families in different areas of low income groups in Amravati city. These water samples were subjected to bacteriological analysis and residual water found to be 48% contaminated after use. The study reported that small families, high socioeconomic status, proper method of collection of water, selection of earthenware container with tap, daily washing of storage container and dipper, proper lid on storage container, use of long handle dipper, washing hands before collecting water, maintaining personal, domestic and surrounding hygiene and by increasing awareness about the waterborne diseases prevents the contamination of household drinking water and water borne diseases. Thus it needs to increase the socioeconomic status, hygienic behavior to prevent water borne diseases. Thus, study concluded that poor hygiene behaviours such as improper method of storage, handling and serving, deteriorates the quality of drinking water which can be improved by imparting water hygiene behaviour education to families .

INTRODUCTION

Water related diseases are the most common cause of deaths. The paucity of clean water for domestic use has led to the increase in the number of deaths in both the urban and rural parts of developing economies. The WHO estimates that there are 2.2 million deaths from diarrhoeal diseases every year in the world, and out of 1.8 million deaths occurred in low income groups, most of them among children, and that 65% of these deaths could be prevented by water hygiene and sanitation interventions (WHO, 2004). And in India, 80% of the infection diseases such as typhoid, cholera, dysentery, and infectious hepatitis etc. are due to contaminated water (WHO 2009; Liu *et al.,* 2012). Nearly 4.1% of the global burden of illness is attributed to water, sanitation and hygiene (Pruss *et al*., 2002).

Most of the water supplied in the urban areas are protected and treated water but still there can be contamination during supply, collection, storage and serving. The reasons for contamination in drinking water in houses may be due to personal and domestic inadequate and unsanitary storage condition that allowed, for the introduction and proliferation of disease causing microbes (Ganesh *et al.,* 2011). Personal and domestic hygiene practices

indirectly depend on the socio-economic condition, formal education of family members. The educated people are more conscious about their health and always try to maintain proper hygienic condition in their houses (Nayyar, 2014). Inadequate hand hygiene practices have been estimated to affect 80% of the population globally (Freeman *et al.,* 2014b). The importance of education, socio-cultural acceptance, changing people's beliefs and behaviours achieved sustainability and affordability in the provision of safe water. Provision of safe household water included the conditions and practices of water collection, storage, handling and the choice of storage containers or vessels. Microbial contamination of collected and stored household water is caused not only by the method of collection and use but unsanitary and inadequately protected (open, uncovered or poorly covered) water collection and storage containers. Unsanitary methods to dispense water from household storage vessels, including contaminated hands and dippers, and inadequate cleaning of vessels, which lead to accumulation of sediments and pathogens (Tambekar *et al.,* 2011; Gundry *et al.*, 2004).

The main objective of the present study was to evaluate the association of behaviour and hygienic practices of family members with reference to household drinking water and waterborne diseases. This study is carried out to find the effect of socioeconomic status, education of family members, water storage and handling practices, types of storage container, dipper used and its washing, hygienic condition of the house and surrounding and awareness on contamination of household drinking water and waterborne diseases.

MATERIALS AND METHODS

A study was conducted in the Amravati city (Maharashtra, India) to observe the effect of socioeconomic status, education, hygienic condition of the house and surrounding, handling practices and personal hygiene on household drinking water. For survey 200 families belongs to different socioeconomic status were randomly selected and water sample before and after used from each family was collected . At the same time the detail survey of sanitary condition of house, health and formal education of family member, frequency of washing the storage container, methods of collection, storage, handling and serving the water were conducted and try to correlate these parameters with the keeping and handling quality and potability of drinking water in houses. The data is collected as per the questionaries prepared for finding the probable cause of contamination.

The above 200 each collected drinking water samples (fresh and residual) were examined for its potability by rapid field Manja's H_2S test (Manja *et al.,* 2001). A 20 ml of drinking water was added directly in to the sterilized glass bottles which contain H_2S medium and incubated at room temperature, the result were observed after 24 hours to 72 hours. The H_2S positive test broth was further processed for the presence of thermotolerant *E.coli* by sub-culturing in tryptone broth for indole test and brilliant green lactose bile broth (Eijkman's test) and incubated at 44.5^0C. All bacteriological media were obtained from Hi-media pvt. Ltd, Mumbai, India (APHA, 2012).

RESULTS AND DISCUSSION

Contamination introduction into storage containers, are probably due to poor storage and practiced poor hygienic handling of water from and in the containers in houses. Potability of drinking water in houses can be associated with poor personal hygiene practices as well as unhygienic environments. WHO (2001) reported that hygiene education might change people's behaviour in storage and handling of drinking water. Even though the clean drinking water is provided, substantial amount of contamination occur while handling at the household level. Contamination in stored household drinking water is associated with the method of storage, handling practices, domestic and personal hygiene practices (Wolf *et al.*, 2014). To find out the probable cause of bacterial pathogenic contamination in household drinking water, the household's survey was conducted.

A total of 200 water samples (fresh and residual water) collected and tested for its potability. Out of 200 fresh water samples 12 were found non-potable and 188 were potable. On examination of residual water samples, out of 188 water samples, 91 were converted to non-potable (Table1). The more number of children or family members affects the quality of water upto 50 to 51% indicating that smaller the family keeps the water free from contamination due to less access to storage water. Educations of the spouse also affect the quality of household drinking water and illiterate spouse contaminated the water upto 58%. The data of the study suggests that the educated women are more cautious and maintain personal and domestic hygiene in the house. Occupation is also important factor which is associated in contamination in

household drinking water; the income of the family depends on the occupation of the owner (fig. 1). The analysis of water data indicated that 51% and 69% water contaminated when the owner and spouse were labour, those were salaried showed 25%. Thus the labours or low income group people could not maintain their drinking water quality as compare to high income group families (Fig. 1). Thus study suggested that for maintaining the quality of household drinking water and avoiding the waterborne diseases; the family should be small, educated and high socioeconomic family. Similarly, Khurana and Sen, (2009) studied the influence of hygienic practices on the incidence of diarrhea in children, relationship with maternal education and socio-economic position. Study was reported that education and better economic position produce better hygienic behaviour.

Table 1: Potability of fresh and residual house hold drinking water			
Potability of fresh drinking water		Potability of residual drinking water	
	Total	Non potable	Potable
Non-potable	12	12	00
Potable	188	91	97
Total	200	103	97

The methods of collection and filtration also affect the quality of water; the water collected by open bucket and without filtration contaminates it more. At the same time the plastic container contaminate the water more (100%) as compare to the earthenware and metal container as plastic or PVC container forms biofilm in the inner layer. The container with tap, 33% water was contaminated and the container without having tap 51% water was contaminated (Fig.1).The data of this study strongly recommended that collection and transport of water in the wide mouth vessel (buckets) is not suitable. The water should be filter and plastic container should not be used. If the storage container has tap then it maintains the quality of the water because there is no dipping of hands and jar and less chance of contamination. Hence the storage container with tap must be use.

If the container is placed above the ground less is the contamination as compared to when placed at ground level. This may be due to entry of dust into the storage container which contains the microorganism. Daily washing of container reduces the water born contamination as compare to alternate day or weekly washing. If the water storage container is not wash daily there is

formation of bacterial slim layer on the wall of storage container and deterioration of water. The hygienic surrounding and use of chorine tablet reduces the contamination. Moreover use of dipper with long handle reduces the contamination as compare to short and no handle dipper (Fig. 2). Addition of fresh water in residual water spoils the quality of drinking water. Hand washing before withdrawing the water reduces the contamination in residual water and keeps the family healthy and free from diseases (Fig.2).

Thus from the observation this study suggests that the storage container should place on the stand, place should be hygienic, personal hygiene and behaviour should be improved. The clean and long handle dipper should be used for water withdrawing from the container. A long handle dipper avoids the dipping of hand in the water and prevents water from contamination. Tambekar and Neware, (2012), Gundry et al., (2004) and Gunther and Schipper (2013) studied that the importance of education, socio-cultural acceptance, changing people's beliefs and behaviours achieved sustainability and affordability in the provision of safe water. Provision of safe household water included the conditions and practices of water collection, storage, handling and the choice of storage containers or vessels. Unsanitary methods to dispense water from household storage vessels, including contaminated hands and dippers, and inadequate cleaning of vessels, which lead to accumulation of sediments and pathogens.

The effect of dipper used, hygienic behaviour of households, awareness about water born diseases, and covering (open or not covered properly) of water storage container prevents the contamination of the water. The bathing before collecting water also reduces (53%) the contamination. Dirty or uncut nails contaminated the water upto 62%. The study resulted that 71% and 68% water contamination occurred when the hygienic condition of the house and surrounding was poor as compare to good surrounding (0% contamination). The open defecation contaminated the water more (56%) as compare to availability of toilets in houses. From the data it cleared that open defecation cause more contamination of water (Fig. 3). Thus the morbidity due to waterborne diseases can be reduced by improving sanitation facility and use of toilets (Wolf et al., 2014; Indian Express, 2015).

Personal and domestic hygiene plays important role in keeping the water potable. The result of the study indicated that family with hygiene conscious members keeps the water hygienic so the study suggests that the awareness program should be run in the society to educate the people on personal, domestic, surrounding hygiene and causes of waterborne diseases in relation to household drinking water. This results concurrence with Tambekar and Neware (2012) which reports that poor domestic and personal hygiene, low health and formal education predispose to water borne diseases. According to Nkusi, (2003) the incidence of wareborne diseases decreases markedly when household water disinfection is coupled with other hygiene measures, especially hand washing at critical times with soap or ash, transporting and storing water safely, and safe disposal of excreta. Thompson *et al.,* (2003) reported that introduction of improved water treatment and storage at the household level, if done effectively, is likely to increase personal and community knowledge and awareness of the importance of water hygiene and sanitation.

Conclusion

The study reported that small families, high socioeconomic status, proper method of collection of water, selection of earthenware container with tap, daily washing of storage container and dipper, proper lid on storage container, use of long handle dipper, washing hands before collecting water, maintaining personal, domestic and surrounding hygiene and by increasing awareness about the waterborne diseases prevents the contamination of household drinking water and water borne diseases. Thus it needs to increase the socioeconomic status, hygienic behavior to prevent water borne diseases. The Safe Water System (SWS) is a water quality intervention that uses simple, inexpensive, and robust technologies appropriate for the developing world to prevent mortality and morbidity associated with diarrhoeal diseases. Improved hygiene and sanitation also play an important role in reducing diarrhoeal and other water-borne diseases.

Thus, study concluded that poor hygiene behaviours such as improper method of storage, handling and serving, deteriorates the quality of drinking water which can be improved by imparting water hygiene behaviour education to families .
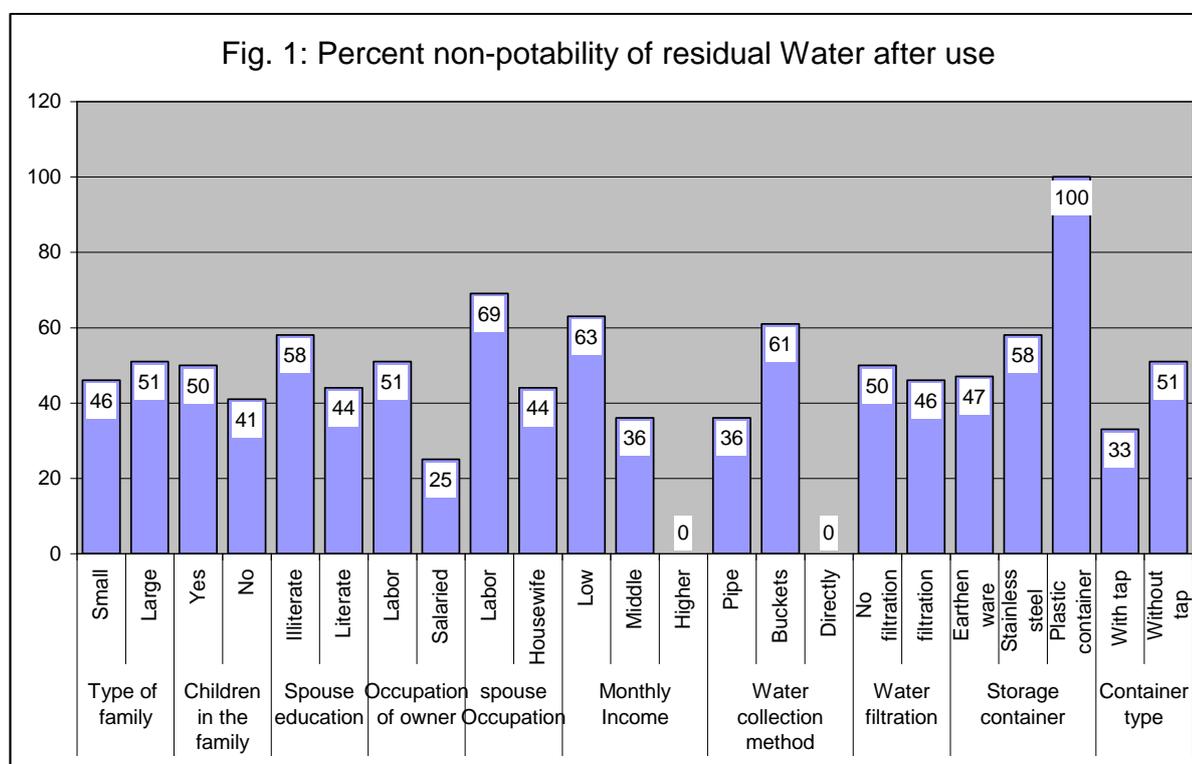

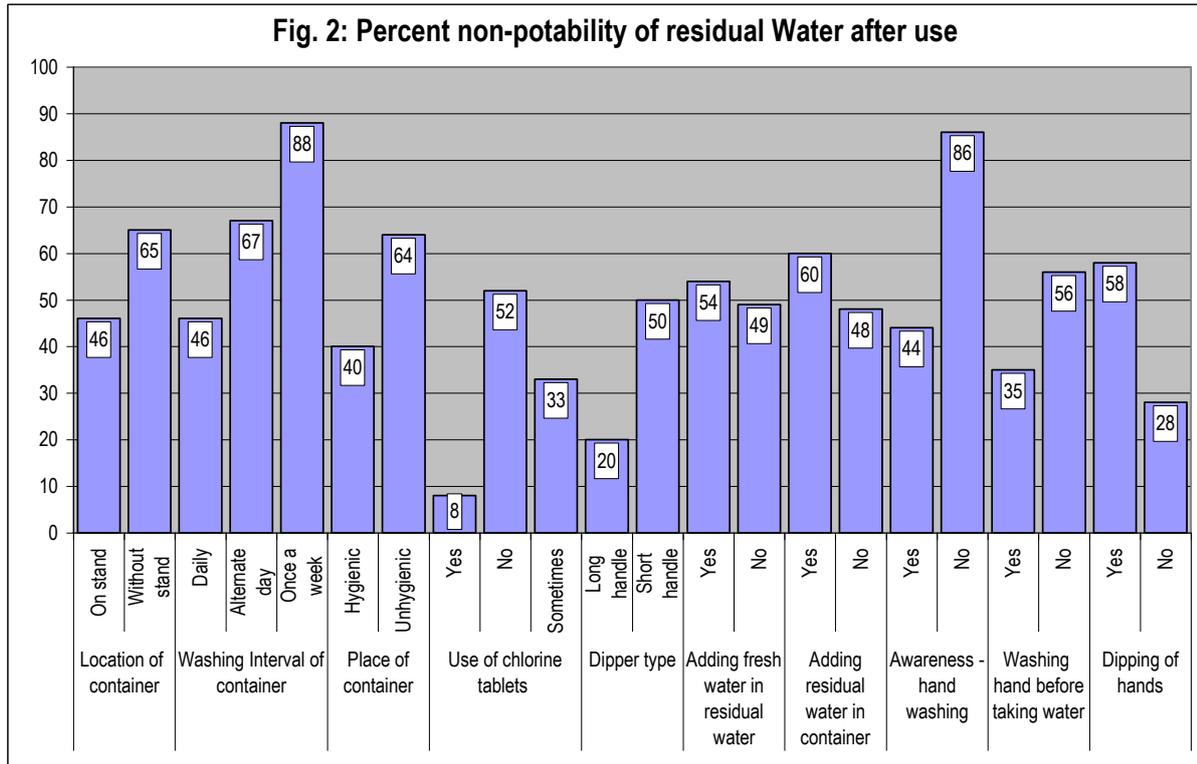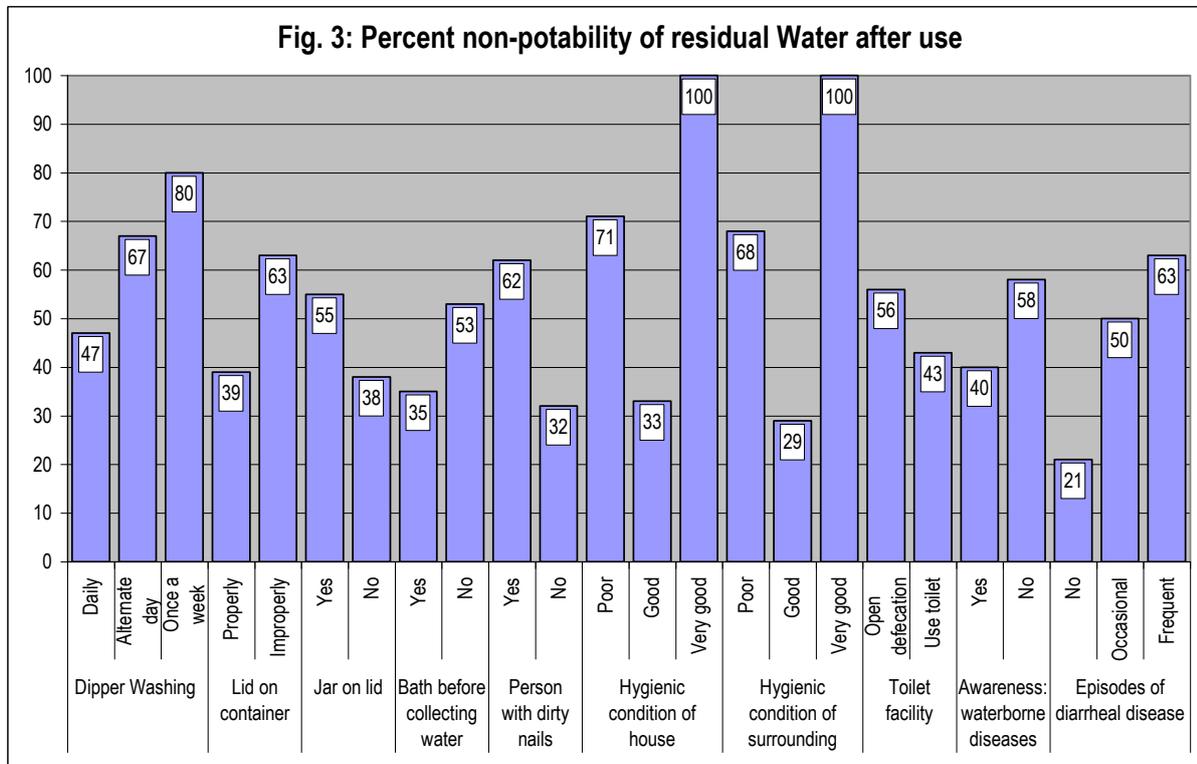Fig. 1: Percent non-potability of residual Water after use

Fig. 2: Percent non-potability of residual Water after use

Fig. 3: Percent non-potability of residual Water after use

REFERENCES

APHA, 2012. Standard Methods for the Examination of Water and Wastewater. (22nd Edn.). Washington DC, 9: 48-51.

Freeman M, Stocks M, and Cumming O., 2014. Hygiene and health; systematic review of hand washing practices worldwide and update of health effects. *Tropical Medicine and international Health*. 19(8): 894-905.

Ganesh SK, Kar SS and Jain A, 2011. Health and environmental sanitation in India: Issues for prioritizing control strategies. *Indian J Occup Environ Med*. 15(3): 93–96 (doi: 10.4103/0019-5278.93196).

Gundry SJ, Wright and Conroy R, 2004. A systematic review of the health outcomes related to household quality in developing countries. *J Water Health*. 02(1): 1-13.

Gunther I and Schipper Y, 2013. Pumps, germs and storage: The impact of improved water containers on water quality and health. *Health Economics* 22, 757-774.

Indian Express, 2015. India reduces open defecation by 31 per cent: UN report, July 1, 2015

Khurana I and Sen R, 2009. Issues and approaches for drinking water quality in rural India: a background paper by WaterAid www.wateraid.org

Liu L, Jhonson HL and Cousens S, 2012. Global regional and national causes of child mortality; an updated systematic analysis for 2010 with time trends since 2000. *Lancet* 379, 2151-2161.

Manja KS, Sambasive R, Chandra SKV, Nath KJ, Datta S, Gopal S, Lyengar L, Dahindas SS and Parija SC, 2001. Report of study on H_2S test for drinking water. *UNICEF*, New Delhi.

Nayyar S, 2014. Sanitation, Health and Hygiene in India Health Issue India February 5, 2014

Nkusi G, 2003. Mobilizing Madagascar households to disinfect their drinking water. Water front. 11-12.

Pinfold JF, 1990. Faecal contamination of water and fingertip-rinses as a method for evaluating the effect of low-costs water supply and sanitation activities on faeco-oral disease transmission. II. A hygiene intervention study in rular northeast Thailand, Epidemiol Infect. 05: 377-389.

Pruss A, Kay D, Fewtell L and Bartram J, 2002. Estimating the Burden of Disease from Water Sanitation and Hygiene at a Global level. Environ health perspect. 110(5):537-542.

Tambekar DH, Kulkarni RV, Shirsat SD and Bhadange DG, 2011. Bacteriological Quality of street vended food Panipuri: A case study of Amravati city. *Bioscience Discovery*, **2** (3):350-354.

Tambekar DH and Neware BB, 2012. Water quality index (WQI) and multivariate analysis for groundwater quality assessment of villages of rural India. *Science Research Reporter* 2(3): 229-235.

Thompson T, Sobsey M and Bartram J, 2003. Providing Clean Water, Keeping Water Clean: an integrated approach. *Int J Environ Hlth Res*, 13: 89-94.

WHO 2009. Global health Risks Mortality and Burden of Disease, Attributable to selected Major Risks. WHO, Geneva. Switzerland.
http://www.who.int/healthinfo/global health_risk/en/index.html.

WHO, (2004). Burden of Disease and Cost-Effectiveness Estimate. Internet.

WHO, 2001. Global Water Supply and Sanitation Assessment 2000 - Report. Geneva.

Wolf J, Prus-Usttin A and Cumming O, 2014. Assessing the impact of drinking water and sanitation on diarrhoeal disease in low and middle-income settings; tropical Medicine and International Health, 19(8): 928-942.