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INTEGRATED DEVELOPMENT FOR WATER SUPPLY AND SANITATION

Storage and local media filters in contaminant removal

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BECAUSE OF THE absence of appropriate and simple means of improving water quality, majority of the Ethiopian population are consuming non-potable water. Storage of raw water in local vessels and filtration of fluoridated water through crushed brick and clay pot are simple methods of treating water.

Samples of water from stream, spring and fluoridated water was used to see effect of storage and appropriate home made filters in the reduction of fecal coliform, turbidity colour, and fluoride. After the samples were initially tested for these parameters, they have been stored for one, two and three days in clay pots, plastic (jerrycan) and metal bucket. The result showed a reduction of fecal coliforms by 100 per cent, 89.6 per cent and 74.6 per cent in metal bucket, plastic (jerrican) and clay pot vessels after three days of storage, respectively. In addition considerable reduction of turbidity and colour was also achieved. On the other hand local clay pots showed effect in reducing fluoride concentration after storage. Filtration of fluoridated water sample through crushed brick and local clay pot have shown an average reduction of fluoride concentration by 57.2 and 93.8 percent, respectively.

This study has revealed that storage of raw water and using clay filters can remove biological, physical and chemical contaminants up to recommended values by WHO. It is believed that with further perfection communities who lack safe water source can use the method just mentioned to purify their water in their homes.

Methodology

An experimental study was conducted in the laboratory of Environmental Health school, Jimma institute of health sciences using fluoridated and raw water.

Samples to be used for physical and biological test were collected from stream and spring in a 20 litter capacity jerrycan which was pre-washed using de-ionized water. For fluoridated water sample, 0.221 gm of sodium fluoride (NaF) salt was prepared using analytical balance and added in to 10 litter of tap water to get 10 mg/l of fluoride concentration. A lower concentration of 3mg/l was also prepared by adding 0.0663 mg of NaF salt in 10 litter of water.

Samples of raw water were stored in different containers which are selected among the popular containers commonly used by people in Ethiopia. The containers used for storage were clay pot, plastic (jerrycan) and metal bucket. After the initial determination of fecal coliform, turbidity and colour; samples were stored in the selected storage vessels (Table 1). Different concentrations fluoridated water (10, 5 and 3 mg/l) were stored in three different clay pots. Plastic jerrycan was also used to store 10 mg/l of fluoridated water as control.

For filtration test, conical filtration apparatus made of sheet metal was arranged. The apparatus has the diameter 50 cm top, 23 cm bottom and a height of 70cm. The bottom part was perforated for the passage of filtered sample. The filtration media was prepared by crushing brick to a size of fine sand to 1 cm across. Generally a total of 0.046 cubic meter of crushed media was used for filtration. Samples having different concentrations of 12.7 mg/l, 5.5 mg/l, and 6.5 mg/l fluoride were poured to the vessel to be filtered through the media. The media was rinsed and washed with deionised water after each sample and before another sample with different concentration is added.

In addition porous and unglazed clay pot was used to filter fluoridated water having concentration of 10 mg/l. After the sample is added to the clay pot filtrate ooze through at a rate of 3 ml/min. The filtrate was then collected, analyzed and compared with the fluoride concentration of the sample before filtration.

Procedures used to determine fecal coliform, turbidity, colour, and fluoride were multiple tube test, turbidimetric, palin test, and SPADNS method, respectively.

Data collection and analysis

Three tests were done for each study parameter with the same step and procedure. Arithmetic mean was computed from the results of each test made for each variable. The most probable number (MPN) of fecal organisms in 100 ml of the original sample was estimated using statistical table of probability table with confidence interval of 95 per cent.

Data were collected from laboratory results of individual values and analysis made after one, two and three days of storage. In addition fluoride data were the result of analysis made after the water has filtered through the crushed brick and clay pot filers. Data were processed using handhold calculator. For compilation, summarization and comparison of data tables are used.

Result and discussion

Storage of raw water is advocated as one of the simplest method of treating water(Kerr, Charles, and Wood, CH. et. al). Filtration of fluoride water through clay material has an effect in removing fluoride concentration (Hauge-S; et al). Storage has shown the effect of eliminating fecal organisms, turbidity, color and fluoride; but the efficiency

Table 1. The average measurement of contaminants after samples

	Study parameter	container type	Day of storage and % reduction					
			0 (initial)	1	% redn.*	2	% redn.	3 % redn.
1	fecal coliform (MPN/100ml)	clay pot	578	578	0	177	69.4	147 74.6
		plastic jerrycan	578	375	35.1	118	79.6	60 89.6
		metal bucket	578	272	52.9	4	99.3	0 100
2	Turbidity (NTU)	clay pot	61.2	48.8	23.5	39.6	35.4	28.3 53.8
		plastic jerrycan	61.2	45.5	26	38.5	37	24.4 60.2
		metal bucket	61.2	46.6	23.8	41.2	32.6	29.3 52.1
3	color (TCU)	clay pot	90	55	38.9	40	55.6	15 83.3
		plastic jerrycan	90	68	24.4	42	53.3	15 83.3
		metal bucket	90	68	24.4	45	50	20 77.8

* *Percent reduction*

of removal depends on the duration of storage and type of container used to store the sample.

The average number of fecal coliform, turbidity, and color before storage were 578MPN/100ml, 61.18NTU and 90TCU, respectively with average pH of 6.44 at a temperature of 20.6 ^{0}C. After one day of storage contaminants has reduced at different degree except the fecal coliform count stored in clay pot. Metal bucket has reduced the fecal coliform load to 4 MPN/100ml(99.3 per cent redn.) and 0(100 per cent redn.) after two and three days of storage respectively. Storage in other containers also showed considerable reduction after three days storage. In the same days of storage turbidity became 28.3NTU, 24.4NTU and 29.3NTU in clay pot, plastic jerrycan and metal bucket containers respectively. And color also became 15 TCU both in clay pot and plastic jerrycan, and 20 TCU in metal bucket after three day of storage (Table 1).

The complete elimination of the fecal organisms in the metal bucket could be due to the sterilizing nature of metals as suggested by Hobbs. As also indicated by Wood. C. H. et al. the reduction in all storage vessels is achieved mainly because, microorganisms are likely to settle in to the bottom together with settleable particles when water is stored in a container. The other possible reason is that, the available food for microorganisms will be diminished when storage time increase, hence the bacterial growth decline.

Among the three containers better reduction was achieved in the plastic (jerrycan). This could be due to the sampling technique conducted to each storage vessel. When samples are taken by dipping, as in the case of clay pot and metal bucket, the water might be disturbed and the settled materials suspend and get in to the sampled water. But in plastic jerrycan sampling was by pouring and relatively clear supernatant water sample might have been collected.

Table 2. Fluoride concentration (mg/l) and per cent reduction (% redn.) of samples after storage in different container, Jimma Oct. 1997

Container type	Day of storage and % reduction						
	0 (initial)	1	*% redn.*	2	*% redn.*	3	*% redn.*
Clay pot 1	10	7.15	*28.5*	4.25	*57.5*	2.3	*77.0*
clay pot 2	5	3.5	*30.0*	1.99	*60.2*	1.2	*76.0*
clay pot 3	3	2.0	*33.3*	1.05	*65.0*	0.7	*76.7*
average value	6	4.22	*29.7*	2.4	*59.5*	1.4	*76.7*
plastic jerrycan	10	10	*0*	10	*0*	10	*0*

Table 3. Fluoride concentration of different water samples after filtration through crushed brick filter media, Jimma, Oct. 1997

water sample	Initial F-conc.*(mg/l)	F- conc. after filtration(mg /l)	*% redn.*
I	12.7	5.85	*53.9*
II	5.5	2.05	*62.7*
III	6.5	2.65	*59.2*
Average	8.23	3.52	*57.2*

**.fluoride concentration in milligram per litter*

Table 4. Reduction in fluoride concentration (mg/l) after filtration of water samples through clay pot, Jimma, Oct 1997.

Water sample	initial F conc.	F- conc. after filtration	*% redn.*
I	10	0.65	*93.5*
II	10	0.62	*93.8*
III	10	0.60	*94.0*
average	10	0.62	*93.8*

Colour reduction that is recommended by WHO which is 15 TCU, was also achieved in clay pot and plastic jerrycan after three days of storage.

Storage of fluoridated water in clay pot and filtration through crushed bricks and clay pot have showed very good fluoride reduction. As the day of storage increase from 1 to 3 fluoride concentration of different aliquots that are stored in different clay pots decreased by 28.5 per cent to 76.7 per cent (Table 2). Better reduction of fluoride is achieved from the samples whose initial fluoride concentration is least. The unchanged fluoride concentration of samples stored in plastic jerrycan reveals that the fluoride concentration reduction is due to contact with clay materials.

In the filtration part, a water sample with fluoride concentration of 12.7 mg/l were filtered through crushed brick media. The filtrate fluoride concentration was found to be 5.58mg/l (53.9 per cent redn.). Other two samples also have shown fluoride concentration reduction filtered through the same media (Table 3).

In case of clay pot filter, the fluoride concentration of the three water samples were 10 mg/l. When they are filtered through the clay pot their average fluoride concentration of the filtrates was 0.62 mg/l (93.8 per cent redn.). Filtration of fluoridated water through clay pots and crushed brick media have eliminated by an average reduction of 57.2 and 93.8 percent respectively. The result achieved by clay pot filtration is comparable with the fluoride reduction by ion exchange method (PURDOM). Hauge-S; et al. in their study have also indicated that, ordinary clay pots and crushed bricks fired at an optimum temperature are efficient to bind fluoride and hence remove it from water. The finding showed defluoridation of water up to the values recommended by WHO.

This simple defluoridation method is applicable in any community whose water sources are fluoridated above the recommended limit. Communities with unclean supplies can improve the quality of their water by storing in metal, plastic (jerrycan) or clay pot vessels.

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