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Original Article

Construction of low cost filters for microbiological purification of drinking water

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Abstract
Unsanitary water is a leading cause of death in low and middle- income countries like Pakistan. For microbial purification of water seven different low cost filters were constructed within 50 ml plastic syringes' cylinders. Filters I, II and III were prepared by mixing different amount of commercially available plaster of Paris and water, while in case of filters IV, V, VI and VII in addition to the plaster of Paris, marble powder and sand were incorporated in different amount in water to make filters. Diluted sewage waters were passed through these filters and the filtrate were then processed for viable counting of bacteria on nutrient agar, eosine methylene blue, (EMB) agar and mannitol salt agar media. Filtrates of filters I, VI and VII gave no growth at all on EMB agar, indicating their coliform retention tendency. Filter V reduced bacterial growth over 10^4- 9.9×10^3 % C.F.U./ml on the nutrient agar and mannitol salt agar media. Keeping in view overall efficiency this filter gave excellent results. These results are suggestive for more work employing different combination of naturally found low cost materials to construct filters of different column length and porosity for convenient microbiological purification of drinking water.

Key words: Microbiological purification of drinking water, low cost filters, water purification.

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INTRODUCTION

The water crisis affects millions of people worldwide and it is expected to worsen over the coming years. Many communities and municipalities obtain drinking water from surface sources such as rivers, streams and lakes. These natural water supplies get polluted by domestic and industrial wastes. Many people even do not know that considerable portion of their drinking water might have been used earlier for domestic and industrial purposes. As a potential carrier of pathogenic organisms, water can endanger health and life.

The pathogenic agents involved include bacteria, viruses, protozoa, which may cause diseases that vary in severity from mild gastroenteritis to severe diarrhea, dysentery, hepatitis and typhoid fever. Although many pathogens can be detected by suitable methods, it is easier to test for the bacteria that specifically indicate the presence of fecal pollution (Goodrich *et al*., 1970; Coleman et al., 1974; Pelczar *et al*., 1986). Coliform bacteria are used to assess the quality of water, although several of the coliforms are not usually pathogenic themselves but they serve as an indicator of potential bacterial pathogens' contamination. The simpler, quicker and safe nature of methods such as most probable number (MPN) technique, membrane filter method, MacConkey agar and EMB agar, etc. for detection and enumeration of these microorganisms as compared to the efforts required to verify the presence of individual pathogens, has made it a popular routine water assay protocol (Guady and Guady, 1980; Benson, 1994; Collins *et al*., 1995; De Boer, 1998; Rompre *et al*., 2002).

Different water sources are characterized by different microbial qualities. Once it is established that a water source/reservoir is contaminated it must be treated to remove or kill the microbial content before it is supplied for human consumption and recreational purposes. The fundamental purpose of water treatment is to protect the consumers from pathogens and other impurities in water. This objective is achieved by introducing barriers such as coagulation, sedimentation, filtration, filtration package plant, diatomaceous earth and

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using activated alumina (Logsdon *et al*., 1990; WHO, 1996). Although many advanced strategies such as U.V. treatment, chlorination, boiling etc. have been developed for microbiological purification of drinking water, but importance of simple filtration has not gone beside the scene.

In drinking water application, the most commonly used filter media are natural silica, sand, garnet sand or ilmenite, crush anthracite, coal and granular activated carbon (WHO, 1996). Faup *et al*. (1977) reported that anthracite coal; activated carbon and peat moss filter media having adsorptive properties can effectively remove heavy metals, coliform and viruses. Clasen *et al*. (2004) conducted a randomized controlled field work to evaluate the effectiveness of ceramic drip filters used by low income community in rural Bolivia and reported that the filters were 100% efficient for removing thermo-tolerant coliform.

It is well documented that filtration proves effective for reducing the incidence and severity of outbreaks, especially in places that lack municipal water treatment (Colwell, 1996; Orland and Lampell, 2000). However, different types of filters are required to be replaced and even this may not be afforded by poor communities. Therefore, there is acute need to work out use low cost material that can easily be employed for microbial filtration of drinking water.

The present study is an effort to identify such materials and methods, which serve the purpose of bacterial removal from drinking water. These results can be extrapolated to develop household filters which are easy to make and affordable even by low income communities.

MATERIALS AND METHODS

Sample collection and Preparation:

Two sewage water samples were collected in sterile bottles at different times. They were brought in laboratory and centrifuged at 2500rmp for 5 minutes to sediment suspended solids. Five ml of supernatant of a sample was mixed with 495ml of autoclaved distilled water.

Preparation of Filters:

Seven types of filters were prepared in plastic disposable syringes of 50ml capacity. Filters designated as I, II and III were prepared by suspending 5, 10 and 15 gm of plaster of Paris in 5, 10 and 15 ml of water, respectively. The mixtures were thoroughly shaken and allowed to solidify, while occupying the bottom areas of the syringes. Filter IV was prepared similarly by mixing 15gm of plaster of Paris in 15ml of water. While, filter V was prepared by suspending 5gm of marble powder and 10gm of plaster of Paris in 15ml of water. Filter VI was constructed by adding 10gms of marble powder and 5gms of plaster of Paris in 15ml of water. Filter VII was made by mixing 5gm of sand and 10gm of plaster of Paris in 15ml of water. After solidifying, the filters were autoclaved at 121°C for 15 minutes.

Processing of the samples

The prepared sample No. 1 was filtered through the filters under aseptic conditions. Similarly the other sample was passed through the filters IV, V, VI and VIII. Various dilutions (1:100, 1:1000, 1:10,000) of the prepared samples as well as the filtrates were made in autoclaved distilled water. Then 0.1 ml of each dilution was spreaded on each of the nutrient, EMB and mannitol salt agar plates. The Petriplates were then incubated at 37°C for 24-48 hrs. Following the incubations, C.F.U. for the different categories of bacteria determined as described by Pelczar *et al.* (1986). C.F.U. of pre and post filtrations were then compared.

RESULTS AND DISCUSSION

The prepared sample No.1 harboured heavy viable bacterial load including *Staphylococcus* spp. (Table I). The filter I filtered all the coliforms. While filter II significantly (upto 1900%) reduce *Staphylococcus* contents. Filters II and III caused surprisingly increase in C.F.U. on nutrient and EMB agar media, respectively. Nature of these filters and porosity intricacies might have splitted chain formers to individual cells or more groups comprising of lower number of bacterial cells which in turn have yielded higher C.F.U. counts.

Processing of sample No. 2 through different filters revealed that filter V, comprising of marble powder and plaster of Paris (1:2) reduced C.F.U. up to 10566%, 1900% and 9900%. Following the processing of the filtrate on nutrient agar, EMB agar and mannitol salt agar media, respectively (Table II). However, the filters VI and VII proved successful in eliminating coliforms from the sample 2 (Table II).

Table I: Colony forming units (C.F.U.× 10^6) on different media representing bacteria of prepared-sewage water sample No.1 before and after passing through different filters.

Experiment	*C.F.U./ml*		
	Nutrient Agar	**EMB Agar**	**Mannitol Salt Agar**
Control	3.8	0.121	4.17
Filter I	3.03 25.41%↓	No. C.F.U.	3.78 10.32%↓
Filter II	TNTC*	1.24 925%↑	0.207 1914%↓
Filter III	6.3 65.79%↑	0.0138 777%↓	1.498 178%↓

*: Too numerous to count.
a: Values in parenthesis indicates %age difference
↑ indicates % age increase and ↓ indicates %age decrease from the respective control.

Table II: Colony forming units (C.F.U.× 106) on different media representing bacteria of prepared-sewage water sample No.2 before and after passing through different filters.

Experiment	C.F.U./ml		
	Nutrient Agar	**EMB Agar**	**Mannitol Salt Agar**
Control	0.64	0.06	0.08
Filter IV	3.56 456%↑[a]	0.002 2900%↓	0.025 3100%↓
Filter V	0.006 10566%↓	0.003 1900%↓	0.0008 9900%↓
Filter VI	0.95 48.4%↑	No. C.F.U.	0.12 50%↓
Filter VII	6.0 837.5%↑	No. C.F.U.	0.059 35.59↓

*: Too numerous to count.
a: Values in parenthesis indicates %age difference
↑ indicates % age increase and ↓ indicates %age decrease from the respective control.

The filters reported in this study were constructed from cheaper and easily available natural material viz. Plaster of Paris, marble powder and sand. Besides different type of recipe, different amounts of water were also tried to construct the filters. The results indicated that in case of filters constructed from only plaster of Paris, the one which was made from the least amount of material i.e. 5gm (filter I) turn out to be more effective in filtering coliforms bacteria as compared to the filters which contained higher quantities of the material. Intensity of porosity in a filter in a filter is not the only factor influencing bacterial filtration processes. As it is established, that electrostatic changes on the surface of filters influence microbial filtration processes (Pelczar *et al*., 1986, Henry *et al*., 2013). It may thus be speculated that different amount of plaster might have created porosity of variable dimensions having differential electrostatic potentials. Regarding the nature of construction materials the present results indicated that addition of marble powder effectively enhanced the bacterial filtration potential of the filters. Inclusion of sand also proved useful in reducing bacterial C.F.U.

The present results were obtained following the filtration of waters through newly constructed filters. However, the filter efficiencies are reported to be influenced by the amount of water filtered and the time taken for its processing. Generally, filter might work better when considerable amount of water had been filtered (Daschner *et al*., 1996). These workers have described that in 4 of 6 filters tested bacterial counts in the fresh filtrate were higher than in tap water so that in some cases, colony counts in filtered water were 10,000 times those in tap water. Thus higher than the control bacterial C.F.U. value of some filtrates obtained in the present investigation following filtration through newly constructed filters are not unusual observations. But the important is that National and International agencies should ensure that either microbial water filters marketed for domestic use are severing the purpose or adding more microbial load in the filtered waters. There is need to work out the best of the filters, reported in this study for longer period of time to measure the efficient phase of a filter. It is very pertinent here to note that all types of filters except filter II removed the coliform bacteria either partially or completely. It reflects the characteristics of the microorganisms that are also important and have bearing on the process of filtration (Pelczar *et al*., 1986, Brown and Sobsey, 2010). These results in general, indicate that apart from coliform bacteria, the filters did not show comparable results for other bacteria. This is a warning situation as in most of the microbiological treatment of drinking water coliform test alone is considered as an established indicator. While many bacteria like *Staphylococcus aureus* and others might not be addressed by a physical treatment and be present well in water being considered safe for drinking purposes based on coliform test (Guady and Guady, 1980; Francy *et al*., 1993). While stressing widespread need of safe drinking water for all the communities Logsdon *et al.* (1990) have described that treatment technologies for small systems should have low construction and operation cost, simple operation, low maintenance and low labour requirement. Results of the present study are promising to employ naturally occurring cheaper materials for constructing effective low cost filters. However, details about physicochemical characteristic, electrostatic and porosity natures of such filters are needed to be worked out in detail for local construction of filters form such low cost and easily available materials.

REFERENCES

BENSON, H.J., 1994. *Microbiological application, Laboratory Manual in general microbiology*. W.M.C. Brown, Dubuque, U.S.A.

BROWN J. AND SOBSEY M.D., 2010. Microbiological effectiveness of locally produced ceramic filters for drinking water treatment in Cambodia. *Journal of Water and Health*,**8** (1): 1–10**.**

CLASEN, T., BROWN, J., UNTURA, O. AND COLLINS, 2004. Safe household water treatment and storage using ceramic drip filters a randomized controlled trial in Bolivia. London School of hygiene and tropical medicine and first water Ltd, Keppel St., London Wc IE 7h, UK. *Water. Sci., Technol.,***50**:111-502.

COLEMAN, R.N., CAMPBELL, J.N., COOK, F.D. AND WESTLAKE, D.W.S., 1974. Urbanization and microbial content of the North Saskatchewan River. *Appl. Microbial*., **2**: 93-101.

COLLINS, C.H., LYNE, P.M. AND GRANGE, J.M., 1995. *Collins and Lyne's Microbiological Methods*. Butterwarth Heine mann Ltd., Oxford.

COLWELL, R.R., 1996. Global climate and infections diseases: The cholera Paradigm. *Science*, **274**: 2025-2031.

DASCHNER, F.D., RUDEN, H., SIMON, R. AND CLOTTON, J., 1996. Microbiological contamination of drinking water in commercial household water filter system. *Eur. J. Clin. Microbiol. Infect. Dis*., **15**: 233-237.

DE BOER, E., 1998. Update on media for isolation of *Enterobacteriaceae* from foods. *J. Food Microbial*., **45**: 43-53.

FAUP, G.M., BEBIN, J.L. AND HACQUART, J.C., 1977. *Progress in water Technology*, **9**:611-620.

FRANCY, D.S., MYRES, D.N. AND MEFZKER, K.D.,1993. *Escherichia coli and* faecal coliform bacteria as indicators of recreational water quality. (U.S. Geological Survey).

GAUDY, A.F. AND GUDY, E.T.,1980. *Microbiology for environmental scientists and engineers*. McGraw Hill Books Co., London.

GOODRICH, T.D, STUART, D.G., BISSONNETTE, G.K. AND WALTER, W.G., 1970. A bacteriological study of the waters of Bozeman Creek's South Fork Drainage. *Proc. Mont. Acad. Sci*., **30**: 59-65.

HENRY, M., MALEY, S. AND MEHTA K., 2013. Designing a Low-Cost Ceramic Water Filter Press. *Int. J. Ser. Learn. Engin.,***8**: 62-77.

LOGSDON, G.S., SORG, T.J. AND CLARK, R.M., 1990. Capacity and cost of treatment technologies for small system. *Journal of American water works Association,* **82**: 60-66.

ORLAND, P.A. AND LAMPELL, K.A., 2000. Extraction- Free, Filter- based template preparation for rapid and sensitive PCR detection of pathogenic parasitic protozoa. *J. Clin. Microbial*., **58**:3257-3262.

PELCZAR, M.J., JR. CHAN, E.C.S. AND KREIG. N.R., 1986. *Microbiology*. McGraw Hill Company, NewYork, U.S.A.

ROMPRE, A., SERVAIS, P., BAAUDART, J., DE-ROUBIN, M.R. AND LAURENT, P., 2002. Dectection and enumeration of coliforms in drinking water: Current methods and emerging approaches. *J. Microbial. Methods*, **49**:31-54.

WHO, 1996. Guidelines for drinking water quality. Volume 2, World Health Organisation,Geneva.