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ORIGINAL ARTICLE

To Study the Efficacy of Bio-Sand Filter for Commercial Use

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ABSTRACT

Water is essential for life. Without water, not only, no one can survive but it also affects health, education and well being of a person. Industrialization, climate change and other environmental factors contributes in contamination of water. Access to safe potable water is basic human right for drinking, and other purposes. Filtration through biosand filter is among one of several methods for the purification of contaminated water. Biosand filter is easy to construct, use and maintain. It can be made from local materials and is also low in cost. The purpose of this study was to investigate the effectiveness of the biosand filter. In this study 30 samples were run to detect the effectiveness of biosand filter. Results suggest that biosand filter effectively reduced microbial load up to 98%. It is also effective in removing suspended particles, turbidity and other impurities from water and improves the taste and quality of water for drinking, sanitation and other purposes.

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INTRODUCTION

Today widespread problem which the world facing is poor and deprived access to clean drinking water. Since access to sufficient water and sanitation services influences everybody's health, education, life expectancy, well-being and social development (1). Safe potable water accessibility has become a human right. Poor water quality and insufficiency has becoming a serious problem worldwide, especially in the rural areas. This situation has been brought about by industrialization and climate change resulting in safe drinking water being a scarce resource. Approximately one billion people have no approach to safe drinking water (2, 3). 2.6 billion People lack basic sanitation. Safe drinking water and basic sanitation are necessary to health and they are being taken for granted (4). Water should be free from contamination (5). For this purpose household water treatment and safe storage is as an effective way to provide clean water to the people in rural areas (6). The household water treatment process is focused on removing pathogens from drinking water (7)] by biosand filtration unit (BSF), designed for household use (8). It is small and does not require continuous delivery of untreated water. A BSF consists of a concrete or plastic container, approximately 0.9 meters tall and 0.3 meters wide. It is filled with specially selected sand and gravel. As water is passed through the filter, physical straining eliminates pathogens, iron, turbidity etc from water. A shallow layer of water is present at the top of sand and forms biofilm (9, 10). It takes 10-20 days for biofilm to develop which consists of bacteria, fungi, protozoa, and

aquatic insect larvae (11).The diffuser plate contains a number of small holes that lower the flow of the influent water and prevent it from disturbing the bio-layer (12). The influent water displaces the water in the filter, and is collected by a drain system present at the bottom of the filter that is removed through a vertical tube. The outlet of the tube is present at a few centimeters above the surface of the sand (13). The biofilm contributes to the removal of pathogens by predation and competition for food (10). The biosand filter can be constructed locally, it is easy to use and maintain, and it is low cost. Water produced by the filters is free of discoloration, odor, undesirable taste and this filtered water can be used for drinking, food preparation and other purposes. These filters are effective in the elimination of viruses, protozoa and helminthes up to 99.9%, and 85% of turbidity (14).

MATERIALS AND METHODS

Sample Size:

The sample size of the project is 30.

Sample Collection:

The water sample was collected from different areas of Karachi including Sabzimandi, Gulshan, Nazimabad #3, Eissa Nagri, Lalukhait, North Karachi, Buffer Zone, North Nazimabad, Gulistan-e-Johar, Dastageer, Shadman, Nazimabad #2, FB Area, and Shahra-e-Faisal, Nazimabad # 4, Nazimabad # 7, Clifton, Garden East, Karimabad, M.A Jinnah Road, Malir, Orangi Town, Saddar, Tower, Azizabad, Lasbaila, Al-Noor and Golimar respectively. The samples were checked for microbial load before and after filtration through biosand filter.

Construction of Biosand Filter:

Pet bottle is taken and upper part of the bottle was cut with the help of hot and sterile cutter. Holes were made with the help of sterile needle in the separated part of the bottle and also in the cap which was already fixed to the bottle. Another hole is made at the lower part of the bottle using the needle. Stick straw from outside at the lower part hole of the bottle with the help of squash tape. Wash the pebbles and gravels 3-4 times with clean water and place them up to 1 inch.

Wash the sand 4-5 times with water and let it dry. Place the sand on to the gravels in the bottle up to 2.5 inch. Place the upper separated part of the bottle in an upside down position in the bottle.

Standard Plate Count:

All the samples were tested by spread plate method before and after filtration. A small volume of serially diluted bacterial suspension is spread evenly over the agar surface using a sterile bent glass rod or wire loop.

Pre-treatment Procedure:

Add 1 ml of water sample in 5 test tubes containing 9 ml distilled water and make 10 fold dilution (1:100 – 1:100,000). 0.1 ml from the last tube is inoculated on nutrient agar plate. Incubate the plate at 37 °C for 24 hours. All the samples were run using above procedure for pre-treatment.

Post-treatment Procedure:

Sufficient amount of water sample is poured to Biosand Filter and collect in a sterile container. Add 1 ml of filtered water sample in 5 test tubes containing 9 ml distilled water and make 10 fold dilution (1:100 – 1:100,000). 0.1 ml from the last tube is inoculated on nutrient agar plate. Incubate the plate at 37 °C for 24 hours. All the samples were run using above procedure for post-treatment.

RESULTS

The research project was carried out to detect the efficiency of locally designed plastic bottle bio-sand filter to reduce the microbial load and for the removal of impurities present in water sample. Results showed that it effectively reduced microbial load up to 98%. 30 samples were tested throughout the project from different areas. From 4 samples microbial load is reduced up to 50% while microbial load is reduced up to 80- 90% in 19 samples. 1 sample reflected complete removal of

Table I: Number of Colonies Before and After Filtration

S. No	Samples	No. of Colonies Before Filtration	No. of Colonies After Filtration
1.	Sabzimandi	++	-
2.	Gulshan	++	+
3	Nazimabad # 3	++	+
4.	Eissa Nagri	+++	+
5.	Lalukhait	++	+
6.	North Karachi	+	+
7.	Buffer Zone	++	+
8.	North Karachi	TNTC	TNTC
9.	North Nazimabad	+++	+
10.	Gulistan-e-Johar	++	+
11.	Dastageer	++	+
12.	Shadman	+++	+
13	Nazimabad # 2	TNTC	TNTC
14.	F.B Area	++	+
15.	Shahra-e-Faisal	TNTC	++
16.	Nazimabad # 4	+++	+
17.	Nazimabad # 7	++	+
18.	Clifton	++	+
19.	Garden East	++	+
20.	Karimabad	TNTC	TNTC
21.	M.A Jinnah Road	++	+
22.	Malir	++	+
23.	Orangi Town	+	+
24.	Saddar	++	+
25.	North Nazimabad	+	+
26.	Tower	+	+
27.	Azizabad	TNTC	+
28.	Lasbaila	++	+
29.	Al-Noor	+	+
30.	Golimar	TNTC	+

*TNTC: Too numerous to count

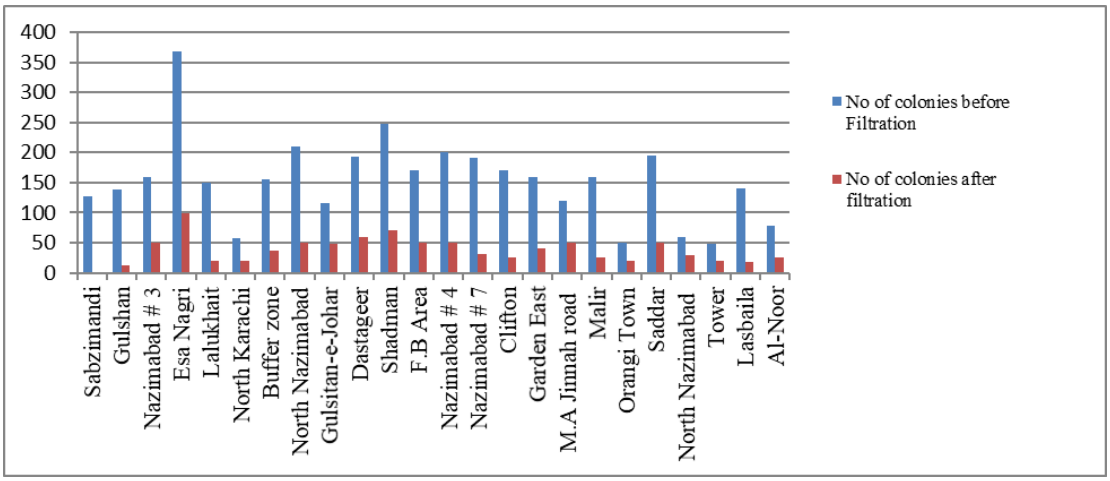

Figure 1: Graphical representation of number of colonies before and after filtration of the samples

microorganisms. Samples with too heavy growth before filtration showed reduced growth after treatment with filter. Results also suggest that biosand filter effectively reduced turbidity from the samples containing turbid water. The randomized trial of the biosand filter suggests that it has the ability of effectively reducing microbial load as well as the turbidity from the water sample.

Figure 2

Figure 3

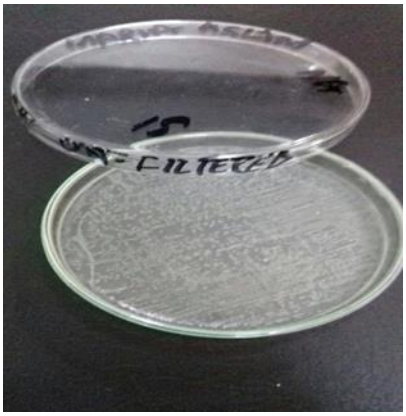

Figure 4

Figure (2-4): Water samples plated before filtration process.

Figure 5

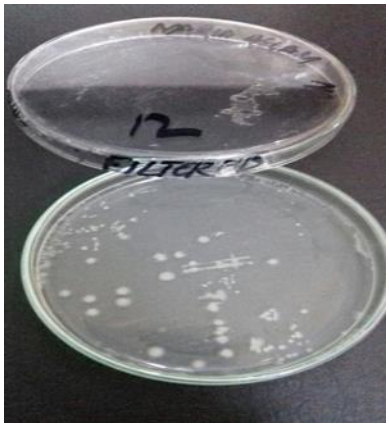

Figure 6

Figure 7

Figure (5-7): Water samples plated after filtration process.

DISCUSSION

The results conducted through the study suggest that Biosand filter is effective in reducing bacterial load from water. The quality of water improved after filtration. Biosand filter reduced microbial load up to 98%. It also reduces the turbidity of the water. Different field and laboratory studies were conducted previously by Buzunis

in 1995, Palmateer in 1997 Baumgartner in 2006, Duke and baker in 2005 which indicates the reduction in bacterial load up to 80 to 98%, viral and protozoan reduction up to 99 to 99.9% and turbidity up to 95% (15). All the results indicate that biosand filters are low cost solutions for water treatment as filter improves the quality of water. The water after filtration through biosand filter is safe for drinking and other uses. I have conducted a similar research study in Jinnah University for Women under the supervision of Department of Microbiology. The research project was carried out to detect the efficiency of bio-sand filter to reduce the microbial load present in water samples. 30 samples were tested throughout the project from different areas. From 4 samples microbial load is reduced up to 50% while 80-90% from 19 samples. 1 sample reflected complete removal of microorganisms. Results also suggest that biosand filter effectively reduced turbidity from the samples containing turbid water. The overall results suggest that biosand filter is effective in reducing the number of microorganisms, suspended particles and other impurities. This makes the water after filtration safe to use for drinking, cooking, sanitation and other household purposes.

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