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Studies on Water Purification using Clay and Organic Waste Products

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Water is one of the most common sources of all infections and water born diseases are one of the most frequently affecting ailments for the human body. While access to drinking water in Indian villages has increased over the past decade, the morbidity and mortality rate due to consumption of unsafe water has continued to affect our population in large numbers. As a solution to this problem a low cost but highly effective water purification system using clay and organic waste products such as tea, coffee and sawdust in different proportions was devised. Organic products used to prepare the filtration systems are used by the villagers in their day to day life and hence are easily available. Bacteriological analyses for number of coliforms using Membrane Filter Technique and Most Probable Number before and after filtration were performed to determine the efficiency of the clay pots.

Key words: *E. coli*, Water pollution, Clay, Organic waste products.

A number of pathogenic microorganisms are responsible for water contamination, but *Escherichia Coli* is known as the indicator of water pollution. As is clearly indicated by the guidelines set by the ISI and WHO.

According to recent World Health Organization (WHO) assessment(Mathys, 2000), there are at least 5 M deaths per year due to the use of unsafe drinking water and at leat 1.4bn do not have access to safe drinking water. According to the WHO guidelines water should be condemned if it is found to contain more than 10 coliform or 1 E.coli/100ml. Hence if there are 2 E.coli/100ml water becomes unsuitable for drinking purpose.

In India most of the population resides in villages, where access to safe drinking water is far from reality. Indian children suffer from water-borne diseases every year. The World Bank estimates 21% of communicable diseases in India are water related. To address such a gigantic problem, novel and low cost solutions are required. The work reported in this paper is one such attempt.

Since time immemorial human beings have understood the importance of drinking water. Over the last two three centuries a new question has come up, the question of water purification.

Tables 1 and 2 show the classificationof drinking water based on bacteriological quality and the ISI standards for safe drinking water.

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Table 1. Classification of water based on bacteriological test

Class	Presumptive coliform /100ml	E.coli/100ml
1. Excellent	0	0
2. Satisfactory	1-3	0
3.Suspicious	4-10	0
4. Unsatisfactory	More than 10	1 or more

Table 2. ISI specifications for drinking water

S. No	Characteristics(microbial)	DesirableLimit	Undesirable effect after the desirable limit
1.	Coliform(cfu/100ml)	1-10	No sample should contain more than 10 coliform per 100ml sample
2.	E.coli (cfu/100ml)	0	No sample should contain E.coli in 100ml otherwise gastro intestinal infection will be caused.

Most of the Indian population resides in villages, where the conditions do not permit access to safe drinking water. They mostly rely on individual wells for drinking water. Moreover the awareness for using safe drinking water is also lacking.

Over the ages pots have been used and humans have considered clay as an important storing and purifying agent. Research is being done all over the world to come up with a technique for water purification which is affordable in nature. Many filtration systems have been reported to remove the contaminants. Water filtration for home use with porous clay and sandstone receptacle dates back hundred of years in central America and Asia.

As Indian villagers use earthen pots to store drinking water, the objective of the present study was to make a suitable water purification system with locally available resources and which can be easily used by individual households for their drinking water needs.

MATERIAL AND METHODS

Preparation of Clay Pots

Inspired by the Tony Flynn filtration system, it was decided to study the use of used coffee, used tea leaves and saw dust to prepare pots with clay in different proportions As this organic material are abundantly available in rural areas. After mixing all the three organic materials in the clay in different proportions separately, the pots were made and dried in the fire kiln. These pots were used as the filtration system, and water was collected in another earthen receiving pot. The use of other such materials may also be considered for preparing the pots. The pots thus prepared were used to study the efficiency for removal of coliforms and fecal coliforms for water samples collected from well waters in Nagpur city

For the purpose of this research help of local potters was taken for the preparation of clay pots. The traditional method of preparing the clay pot on the potter's wheel was used. Used tea leaves, coffee and saw dusts were procured by the researcher from the local markets.

Used tea leaves and coffee were washed and dried in hot air oven for use in the present research. This raw material was mixed with clay in different proportions. Clay pots were prepared using organic matter i.e. tea, coffee and saw dust in different proportion. The different proportion used were as follows.The pots were marked as 30T,40T and 50T, 30S,40S,50S and 30C,40C,50C in case of pots made with used tea, saw dust and used coffee respectively. Control was taken as the pot made with only clay without any organic material in it.

Control - 800gram of clay

750gram of clay + 50 gram of tea (50T/50S/50C) i.e. 6.25% used tea/ sawdust/ used coffee
760gram of clay + 40 gram of tea (40T/50S/50C) i.e. 5.00% used tea/ sawdust/ used coffee
770gram of clay + 30 gram of tea (30T/30S/30C) i.e. 3.75% used tea/ sawdust/used coffee

Pots with Used tea

Pots with Sawdust

Pots with Used coffee

Set up of the filtration system

Filtration system 50T

Receiving pot

Filtration system 50T
inserted in the receiving pot

Sample Collection

Well water samples were collected in sterile water bottles from different areas of Nagpur city.

Water Filtration through the pots

Water samples were filtered through different filtration systems and collected in the receiving pots. Time required for complete filtration by the different filtration systems were measured and compared.

Test for coliforms and fecal coliforms were conducted using Membrane Filter Technique (MFT) and Most Probable Number (MPN), to determine the efficiency of the clay pots to remove the coliforms.The Brilliant green lactose broth(BGLB) was used for detection of coloforms by MPN. M-endo agar and M-FC agar from Hi media were used to enumerate total coloforms and fecal coliforms respectively. Water samples were tested for presence of total and fecal coliforms

before and after filtration through the clay pots and efficiency of removal of Total Coliforms and Fecal Coliforms was studied.

RESULTS AND DISCUSSION

Water sample after collection were passed through the clay pots and the time required to filter it completely was measured. 250ml of well water collected from different areas of Nagpur were kept in the clay pots for filtration. The filtration rates were as follows:-

Control- 30hrs

50T- 13hrs	50S-20hrs	50C-28hrs
40T-14hrs	40S-18hrs	40C-27hrs
30T-15hrs	30S-17hrs	30C-25.5hrs

Out of all the filtration systems, tested for reduction in coliform content 50T proved to be the most efficient one. The time required by 50T was 13 hrs. In order to further test the efficiency of this filtration system, water sample procured from the same location was kept undisturbed for 13 hrs and then reduction in its coliform content was determined using Most Probable Number and Membrane Filter Technique and was labeled as Control 1.

Fig 1 and Fig 2 show the percentage reduction in the no. of total coliforms and fecal coliforms respectively by the different filtration systems.

Control 1 indicates the reduction percentage of coliform (total/fecal) in case of water kept undisturbed for 13 hrs where as Control 2 indicates filtration system made up of 100% clay.

Six out of ten samples filtered with 50T gave 99.9% reduction of total as well as fecal coliform. The first sample in which 99.9% reduction was obtained was tested twice in order to check the consistency in results.

In the first set of experiment water was treated with $CaC0_3$ and bleaching powder, as a result of which before filtration very less growth

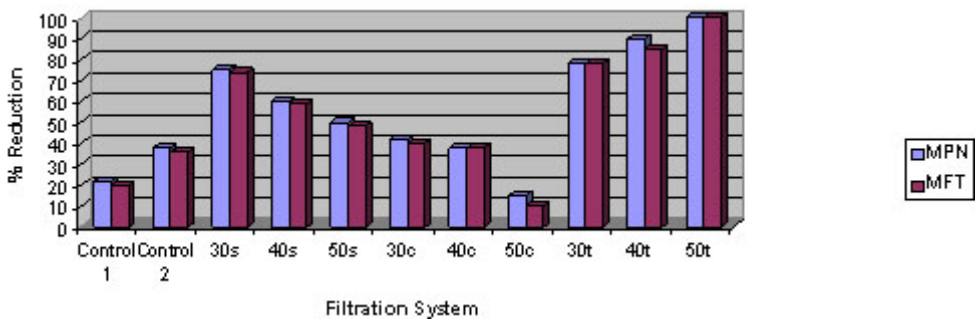

Fig. 1. Percentage reduction in the no. of total coliforms(by MPN and MFT)

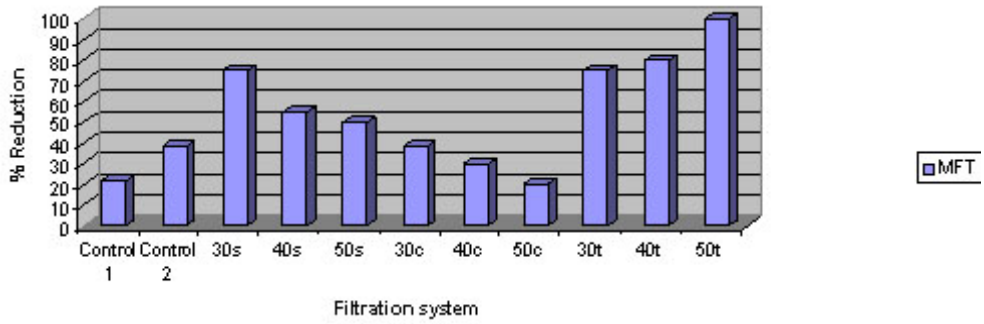

Fig. 2. Percentage reduction in the no. of fecal coliforms(by MFT)

was obtained on the plates of MFC as well as M.endo agar. Over a period of two months the effect of these chemicals had diminished, as a result of which heavy growth was obtained on the agar plates in samples tested before filtration.

In both the cases 50Tshowed the same results i.e. 99.9% reduction of total and fecal coliform.

In the present study the results obtained with coffee and clay are comparable to that of the control pots without any organic material, in contrast to those obtained by Tony Flynn who obtained about 99% removal. The particle size of the clay as well as that of the coffee powder, at the same time the pore size of the filtration system could be the reason behind this difference in the results. So it becomes important to study the particle size of the clay as well as that of the organic material which is being used to make the pots.

Plate 1-plate 6 show the results of Membrane Filtration Technique on MFC and M.endo Agar before and after filtration

Fecal coliforms on MFC Agar
Pre-Filtration

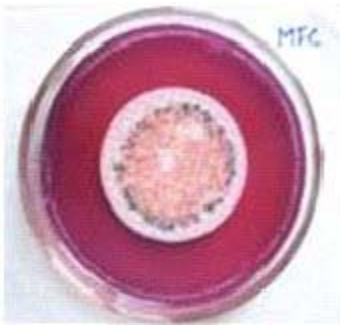

Plate 1

Total coliforms on M.endo Agar

Plate 2

Post- Filtration

Plate 3. Control

Plate 4. Control

Plate 5. 50 T

Plate 6. 50 T

CONCLUSION

In the present research work 50T was found to be most effective in removal of total coliform and fecal coliform (99.9%) as compared to the other filtration systems. Hence a clay pot with optimum concentration of organic material could be easily prepared by the villagers, who regularly use clay /earthen pots for storing their drinking water. This type of system can be easily used by villagers to obtain safe drinking water at low cost.

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