ORIGINAL ARTICLE

EFFECTIVENESS OF DOMESTIC WATER FILTERS IN REMOVING SUSPENDED SOLIDS, RESIDUAL CHLORINE AND COLIFORM BACTERIA

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ABSTRACT

Water filters are being increasingly promoted and used in the home. There are many types of commercial water filters available for domestic use but almost all of them employ a physical filter media and an activated substance. The study showed that water filters effectively removed suspended solids and residual chlorine. However, as far as removing coliform bacteria is concerned, in 22.5% of the cases, bacteria were in fact introduced into the water. And in 20% of the cases, the amount of bacteria introduced was "too numerous to count (TNTC)". Furthermore, water filters can lose their ability to filter bacteria without losing their ability to filter suspended solids and residual chlorine. This highlights the necessity of some authorized body looking into the claims made by these water filter manufacturers and impose certain standards to ensure that at the very least, the water quality of the filtered water is not worse than the unfiltered water.

Key words: *Water filters, suspended solids, residual chlorine, coliform bacteria.*

INTRODUCTION

Water as a natural resource is gradually dwindling and it has been postulated that the next "big" war will be over water. In the many areas where water is abundant it is still interesting to note that potable water is not so available. Even in Cameron Highlands where rain is in abundance and rivers course through our hills, virgin catchment areas are rare. In most catchment areas there will be some invasion resulting in pollution of our drinking water. Although water treatment plants improve the quality of water passing through it, samples of drinking water taken failed the National Quality Assurance1 tests. The number of water borne diseases and the many threats to our health that may arise from the poor quality of drinking water is too numerous to detail here. Moreover, the potential of resulting epidemics cannot be over-emphasized.

It is precisely for this reason that companies dealing with domestic water filters (from here on known as water filters) have managed to convince a health conscious public on the need for extra water treatment capability in the home. While one cannot argue against the effectiveness of water filters as a whole, there is a tendency to forget that water filters have a life-span. When the life-span of the filter is exceeded water filters can actually do harm.

In general, almost all water filters will have a physical filter medium and/or an activated substance. The physical filter may range from straightforward fibre material filters to sophisticated membranes allowing for the filtering of suspended particles to bacteria and even dissolved compounds. However, this physical filter will clog up over time and therefore reducing its efficacy. Furthermore, a biofilm of bateria will form on the filter itself resulting in the filter becoming a source of bacteria growth.

The activated substance is most likely to be activated carbon which attracts ions and removes odors. After a period of time or usage, the activated carbon becomes deactivated.

The aim of this study is to determine the effectiveness of domestic water filters base on its ability to remove suspended solids, residual chlorine and coliform bacteria.

The main objective of this study is to show that water filters can actually do more harm than good as bacteria can be introduced into the water.

METHODOLOGY

Since there are no figures on how many homes have water filters, an arbitrary figure of 40 samples was used. This figure was chosen with the assumption that at least 5% of the 4,886 occupied dwelling units in Cameron Highlands[2] has a water filter system in their house. Selection of the houses was based on the geographic distribution of houses in Cameron Highlands. Two houses were chosen at random from each village (8 villages in all) with the

remaining houses chosen from Tanah Rata and Brinchang because half the population of Cameron Highlands is found in these two towns.

Water samples were taken from kitchen taps before and after passing through a domestic water filter. The water samples were then tested for turbidity, residual chlorine (RCL) and total coliform (TC). The method of testing is in accordance with the guidelines approved by the Ministry of Health Malaysia[3].

The Millipore Test Kit was used to test for TC with units of measurement in "colonies / 100 mls". This represent the older unit of measurement as compare to "MPN/ 100ml" as used by the Chemistry Department. The acceptable standard for drinking water is TC < 5 col / 100ml.

A Turbidity meter (Hach) was used to measure turbidity with units of measurement in NTU. The acceptable standard for drinking water is Turbidity < 5 NTU.

A Chlorimeter (Hach) was used to measure the amount of chlorine with units of measurement in parts per million (ppm). The acceptable standard for drinking water is chlorine > 0.2 ppm.

RESULTS

For simplicity, the suffix "pre" represents "before the filter" while the postfix "post" represents "after the filter". For e.g. Turbidity-Pre means turbidity of the water before passing through the filter while Turbidity-Post means turbidity of the water after passing through the filter. The same goes for Residual Chlorine (RCL-Pre and RCL-Post) and Total Coliform (TC-Pre and TC-Post).

A. Turbidity (Standard < 5 NTu)

The turbidity test reflects how effective the filter is in removing suspended solids from the water. For the pre-filtered water, 10 out of 40 (25%) exceed the standard for drinking water. For the post-filtered water, none (0%) of the samples exceed the standard. More importantly, all (100%) the post-filtered water has a lower turbidity compared to its pre-filtered sample. Refer to Table 1.

Table 1: Results of Turbidity testing of pre-and post-filtered water.

Test	Number	Percentage
a. Turbidity-Pre > 5 NTu	10/40	(25%)
b. Turbidity-Post > 5 NTu	0/40	(0%)
c. Turbidity-Post ≥ Turbidity-Pre	0/40	(0%)

B. Residual Chlorine (Standard > 0.2 ppm)

The Residual Chlorine (RC) test reflects how effective the filter is in removing residual chlorine from the water. For the pre-filtered water, 17 out of 40 exceed the standard for drinking water. For the post-filtered water, all the samples were below the standard. And in all the samples of post-filtered water has a lower level of RC than the pre-filtered water. In addition, 39 of the post-filtered water have no residual chlorine. Refer to Table 2.

Table 2: Results of Residual Chlorine testing of pre- and post-filtered water.

Test	Number	Percentage
RC-Pre > 0.2 ppm	17/40	(42.5 %)
RC-Post > 0.2 ppm	0/40	(0 %)
RC-Post ≥ RC-Pre	0/40	(0 %)
RC-Post = 0.0 ppm	39/40	(97.5 %)

C. Total Coliform (Standard < 5 per 100ml)

The Total Coliform test reflects how effective the filter is in removing coliform bacteria from the water. For the pre-filtered water, 20 out of 40 (50%) exceed the standard for drinking water. Of this 20 samples, 10 were "too numerous to count" (TNTC). For the post-filtered water, 14 out of 40 (35%) exceed the standard. Of these 14 samples, 8 were TNTC. Refer to Table 3.

Table 3: Results of Total Coliform testing of pre- and post-filtered water.

Test	Number	Percentage
TC-Pre > 5 per 100 ml	20/40	(50.0 %)
TC-Pre = TNTC	10/40	(25.0 %)
TC-Post > 5 per 100 ml	14/40	(35.0 %)
TC-Post = TNTC	8/40	(20.0 %)

This data gives the appearance that the filters are actually effective in removing coliform bacteria as the number violating samples is less post-filtered. But a comparison of the pre-filtered and its corresponding post- filtered water sample revealed that in 9 out of 40 samples (22.5%), the post-filtered water has a higher count for coliform bacteria than its corresponding pre-filtered sample. And 8 of the 40 post-filtered water became TNTC while its corresponding pre-filtered counterparts were clear of coliform bateria (0/100 ml). Refer to Table 4.

Table 4: Results of Total Coliform testing of post-filtered water compared to its corresponding pre-filtered water counterpart.

Test	Number	Percentage
TC-Post > TC-Pre	9/40	(22.5 %)
TC-Pre = 0/100ml and became TNTC after filtered	8/40	(20.0 %)

DISCUSSION

The results for Turbidity and Residual Chlorine tests showed conclusively that water filters effectively remove suspended solids and chlorine from the water as in all the samples, the post-filtered water has a lower level of turbidity and residual chlorine than its pre-filtered sampled.

However, the results for Total Coliform tests deserve attention. While Table 3 showed that water filters do reduce coliform bacteria, Table 4 showed that in 22.5% of the samples the coliform bacteria count is actually higher after passing through the water filter. In short, coliform bacteria were introduced into the water from the filter! This finding is consistent with the study done by Daschner *et al* (1996) [4] where 24 out of 34 (70.6%) of the samples of filtered water were found to have an increased bacteria count. This suggests that the bacteria growth or biofilm formation in the filter material which is subsequently released into the water passing through it.

Another observation from the above results is that at least 22.5% of the filters lost their ability to filter coliform bacteria without losing their ability to filter suspended solids and residual chlorine. Again this is consistent with the findings of Daschner [4] out of 6 fresh filtrate had a higher bacteria count in the tap water after only 1 week of use. In some cases, the colony count was 10,000 x that of the tap.

Alabi *et al* [5] showed that most of the 100 samples of water tested from home filters from the university community were grossly contaminated. While he did not test for contamination in the pre-filtered water he did looked into the fitness of the filter candles, the frequency of cleaning the candles, the source and the PH of the water. And he concluded that these attributes did not significantly affect the microbial quality of either filtered boiled or unboiled tap water.

CONCLUSION

Water filters can become a source of bacteria contamination and this happens without interfering with its ability to filter suspended solids and residual chlorine. Therefore, the user may not be aware that this is happening, as the filtered water appears "clean". Furthermore, this can occur after just one week of use of the water filter whereas the general user usually changes the filter media after a few weeks or even months; or when the filter appears dirty. The danger is compounded when manufactures recommend filtered water to be taken without boiling.

Therefore, it is always advisable to boil our drinking water even though it has been filtered. It is also suggested that the relevant authorities look into the claims made by some water filter manufacturers. Standards should be set for manufacturers of filters and violators should be prosecuted. People should be educated to the usage of filters in the brochures provided by the manufacturer.

REFERENCES

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