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The Usage of Home Water Filtration System in Malaysia

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Abstract: Installation of a water filter system for household use has become a necessity for Malaysians to get safe drinking water quality. Various types of machinery products of water filters have entered the Malaysian market with certain quality assurance. In the present, there were no guidelines for the water filter system in Malaysia that can prove water quality assurance given by the provider. The aim in this study is to produce a good reference based on the factor affecting the user choosing a water filter system. The method that was used is the collection of data from the questionnaire and survey of feedback from consumers. This result can determine the pattern and selection factor of a water filter machine product. The major factor in the selection of water purifier machines is the price offered and the main information about the product is obtained through the advice of friends and neighbours. The second aim of this study was conducted to determine the quality of the water filter before and after through a water filter system. The results of water quality tests before and after through water filter system showed three forms of concentration changes in chemical water quality parameters were tested. First forms of concentration, there was a high percentage removal rate that exceeds 75% in all types of water filter brands. Second, the result of the water quality test for tap water and after filtering water sample shows no significant difference for the concentration parameters before and after passing through a water filter system. Third, there was an increased in the concentration of water after through water filter system. The results of chemical water quality test for three brands which have twelve parameters was given good performance on Brand A (Model 1). However, the water quality before and after passing through a water filter system still meets drinking water standards of the Ministry of Health. The results of this study can be used as a reference source for Safety Division and Food Quality, Ministry of Health Malaysia in developing water filter system guidelines for household use.

Keywords: Water filter system, chemical water quality test, questionnaire, Ministry of Health

1. Introduction

Water is the most important and precious resource for human survival [1]. Regarding knowledge of the community, the quality and safety of the drinking water still are an important public health issue [2]. Rapidly expanding public water demand conditions promote an associated stress on water quality, particularly in urban areas where industrial and even agricultural processing combine with more concentrated municipal activities to intensify discharges of potentially harmful materials to public waterways [3]. The burden of diseases from inadequate water, sanitation and hygiene totals 1.8 million deaths and the loss of greater than 75 million healthy life years [4]. The safe and clean drinking water needs to become a priority for Malaysians in order to get safe drinking water sources in their daily lives.

Consuming enough water in our daily life is a must to stay hydrated and healthy. Popular problem ideas of tap water quality deficiencies include fear of introduction of pathogens in the distribution system, high level of chlorine, fine

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microscopic which causes cloudiness, bad taste and smell, the presence of sediments or presence of metal pollutants as lead [3]. There is relatively little public awareness of organic substances such as trihalomethanes (THMs). In addition, the chlorination method used for disinfection at domestic water treatment plants has the potential to cause health risks to consumers such as the formation of halo-organic carcinogen compounds, as a by-product of the chlorination process and the main problem is trihalomethane [5, 6]. It was shown that although the water channeled to the population has undergone one stage of water treatment at the water treatment plant, but during the collection, distribution, and storage process due to low levels of hygienic and infrastructure failures will affect the quality of the water and is not safe to drink directly [7,8]. Nowadays, the production of biofilm is a major problem in water distribution systems as well as in home water filtration system [9]. If biofilm attaches to the surface of the hidden devices and the microorganisms can become a source of undesirable levels of opportunistic pathogens or endotoxins in water supplies [10]. The Malaysian government has determined that all water sources for drinking should comply with the National Drinking Water Quality Standards guidelines.

Increasing awareness on the matter has caused many Malaysian consumers have to install a water filtration system at home [17]. Hence, the private sector has developed and brought water for household use filtration technology aimed at improving the quality of drinking water and reducing the threat of water-borne diseases. Filtration operates entirely on particle or droplet size to some extent shape such that particles below a certain size will pass through the barrier, while larger particles are retained on or in the barrier for later removal [11]. Filtering can make the water more contaminated if filters are not changed regularly.

Various types of water filter systems are available in the Malaysian market using various filtering media such as silica, sand, activated carbon, fiber and fine woven fabrics [12]. This filter is used to hold the water impurities and produce clean water after filtering [13]. Activated carbon is a material commonly used in water filtration systems as it is able to absorb various pollutants found in water [14, 15]. The function of sand filter media normally used to trap and remove taste and odor from water [17]. In addition, there is also the use of nanotechnology methods such as nanotubes, nanotechnology, and membranes capable of removing heavy metal ions and toxic chemicals in water [16]. Based on the previous studies, activated carbon filter and membrane filter are the common, cheaper methods, easy to install and maintain compared to other filtration systems [17].

Various types of filter media system are available in water filtration systems, where consumers can choose according to the suitability of a situation and the number of households. The main reason selected home water filter system might due to its cheaper price compare to other expensive types of water filters, therefore consumers are more affordable to install the low cost of water filter system [17]. In a lot of cases, the filtration systems could purify the water. All things considered, treated water quality that will pass through the water filter are varied base on the source of the water. In this way, broad investigation ought to be led for ensuring the most dominant brands by the consumer choices to produce high efficiency in good quality of water after passing through water filter system and for sustainable use. Additionally, the machine also has no strict scientific evidence for continuous machine use, positive health effects and safe water quality for use that exceeds a prescribed period. Furthermore, a public survey is the important factor to collect public's opinion about the supplied water quality, the consumer understanding about the home filter system and the reasons consumer install home water filter systems [17].

The objectives of this study were to determine the types of dominant filters used by residents in Malaysia by conducting a questionnaire survey, whereas water that has undergone treatment through a home water purifier system should also be tested to ensure that the filtered water follows Regulations 394 (1) and 360B (3) of the Food Regulations 1985 Table 25. The result from the questionnaire was used in this study to analyze the selected brand and the quality of the home water filtration system. The analysis of the brand home water purification system was discussing three brand water filter system was used in Malaysian. The mean and range of concentrations for chemical water quality parameters were calculated to obtain comparisons of water quality from the three selected brand water filter.

2. Methodology

2.1 Primary Data Collection - Qualitative Analysis

A set of questionnaires were constructed using googles form. The questionnaire was open within 2 two months of the collection period. 130 number of respondents throughout Malaysia give feedback on the questionnaire. The form of questions contained in the set of questionnaires is as follows:

i) The location of residence
ii) Brand of home water filter machine used in home
iii) The period for using a water filter machine
iv) The type of water source used
v) How often does water filter systems be maintained (maintenance)?
vi) How consumer gets information about water filter system products
vii) What is the primary factor that emphasized the consumer in the selection of water filters products?

2.2 Testing Water Quality - Quantitative Analysis

2.2.1 Sampling

Water collection was carried out in accordance with the standard method procedures [18]. Equipment used for sampling is a plastic bottle that has a volume of 1000 ml [18]. Water samples are taken directly from the tap and after through the water filter system. All sampling bottles labeled with information such as a number of samples, the date and time.

2.2.2 Method of test and analysis instruments

Water quality parameters were tested according to standard methods for the examination of water and wastewater [18]. Table 1 shows the methods and equipment used in the testing of water quality.

Table 1 - Instrument parameters and water quality testing

Parameter	Instruments
Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Manganese (Mn), Selenium (Se), Silver (Ag), Zinc (Zn)	Inductively Coupled Mass Spectrometry (ICP-MS)
Chloride (Cl), Fluoride (F), Nitrate (N), Sulphate (SO_3)	Ion Chromatography (IC)
Mercury (Hg) Magnesium (Mg) Sodium (Na)	Mercury Analyzer Atomic adsorption spectroscopy (AAS)

3. Results and Discussion

This section is the result of the analysis and discussing of the results obtained from the experimental study of water quality from the water filter system. Besides that, the results obtained from the collection of primary data through a questionnaire survey.

3.2 Analysis of the Survey

A total of 130 respondents have responded to the questionnaires that provided through the Google form application. Respondent's distribution covers the entire state in Malaysia except for Sarawak and Perlis. Fig. 1 shows the main brands of water filter machines located in Malaysia by consumers. The most popular types of water filter system used by consumers are brand A (27.7%), B (12.3%) and C (7.7%).

In general, the dissemination of the primary information sources in the selection of water filters machine is through friends or neighbors representing 45.5%, followed by information through salesman product (26.2%) and their own search (20%). Based on the results, it clearly seen that influenced by friends and neighbors was the most crucial part to know about water filter machine. This is because they might be realized (friends and neighbour) about the presence of the water filter machine is from the internet or media social. Based on the previous study, it has been stated that media social is the vital sources for supply the data based on the case of environmental [19]. While the selection factors of water filter machines have shown that most respondents (43.8%) agree that the price offered by a water filter machine is a major factor in the selection of the product. The services offered (38.5%) and the design of a water purifier (36.9%) are the second and third factors that are the respondents' choice. From the results, the price is the most demand part to select the water filter machine. Furthermore, the results compared with the previous study on 'Malaysian households' drinking water practices: A case study' results stated that aware of health is the most important why the consumers purchased the water filter machine with 67% [19]. This can be clearly seen that from previous study results, the consumers are more attracted to aware of health rather than price.

Subsequently, data shows the criteria for the use and maintenance of water filter machines affecting the usage period, maintenance period and water resources used by most consumers in Malaysia. Most of respondents used water filters within 1-5 years (56.2%). Other than that, the use of a water purifier machine for less than a year and over 5 years is 17.7% and 26.2% respectively. The duration of maintenance for a water filter is dependent on the package offered by the manufacturer. From the results show that, periodic maintenance every 2-5 months and 6-12 months is the dominant compared to the respondents who stated periodic maintenance period per month was 11.5% and 6.9% who had never maintained a water filter machine since its inception. The maintenance for water filter machine is important to produce good water quality. This is because the poor maintenance or not caution about the health can give the bad effect for the consumers. The previous study on 'Evaluation of a new water treatment for point-of-use household applications to remove microorganisms and arsenic from drinking water' stated that the disease such as waterborne comes from unclean of drinking water [20]. This is crucial for the consumers for more care about the maintenance of a water filter machine. Lastly, the majority of the water sources used in the water purifier are derived from tap water.

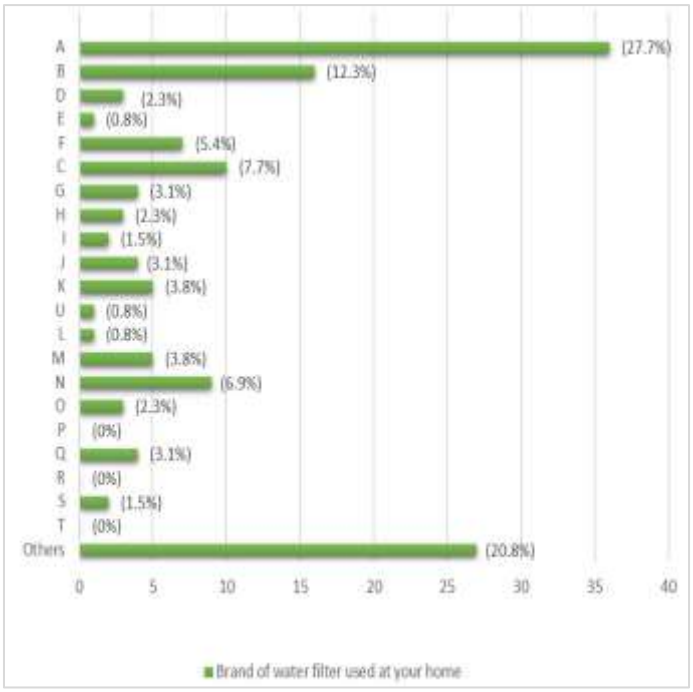


Fig. 1 - Brand of the home water filter system

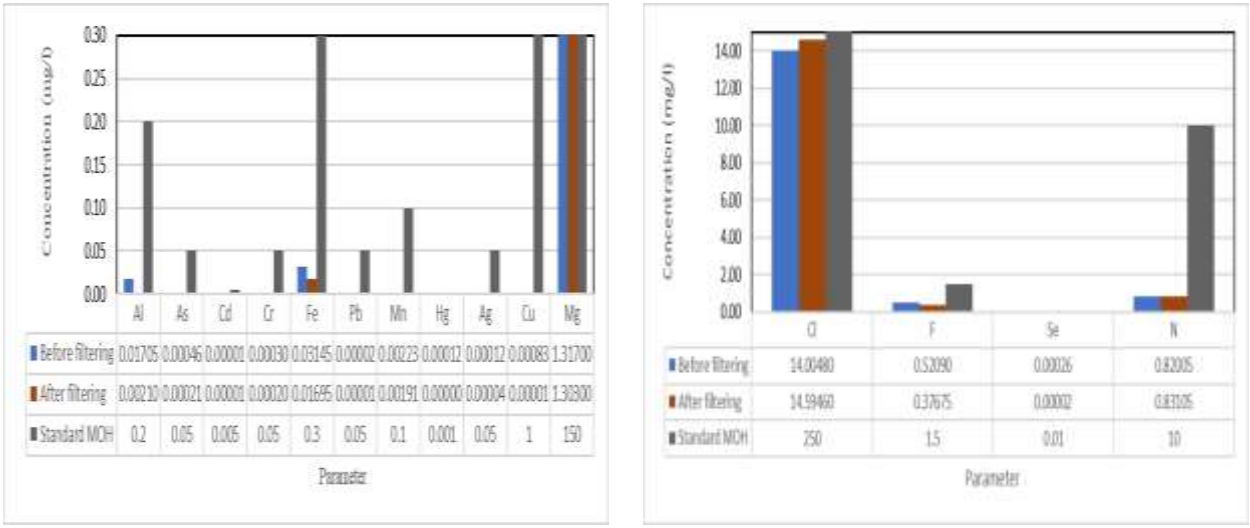
3.2 Analysis of Water Quality of the Water Filter System

3.2.1 Brand A (Model 1)

The selected water quality analysis for the water filter system is discussed in this section. Fig. 2 shows the results of water quality for water filter system brand A, model one located in Parit Raja, Batu Pahat. The date latest water filter system is maintained at 10/06/2017. Overall, the water quality parameters testing for water samples before and after the water filters system meet drinking water standards of the Ministry of Health. Refer to Fig. 2 (a), the effectiveness quality of the water filter system is proven by the parameters that exceed 85% percentage removal of aluminum, mercury, copper and selenium. Percentage removal of parameters such as arsenic, chromium, iron, lead, silver and fluoride are between 30-65%. Even though, there is a percentage increase in the parameters concentration of chloride (4.2%) and nitrate (1.3%) in the water after passing through the water filter system respectively. This due to tap water contains high concentrations of chloride and nitrate as shown in Fig. 2(b). Thus, the two parameters of heavy metal from tap water may flow into the water filter system and reduce the quality performance of the water after filtration process [21]. The experimental result after filtering should give good performance compared to before filtering from tap water. The main reason filter water becomes more contaminated with the system is not regular maintenance to change the filter media exhausted and clean the system. Each water filter has defined removal capacity and must be replaced when this capacity is exhausted [22].

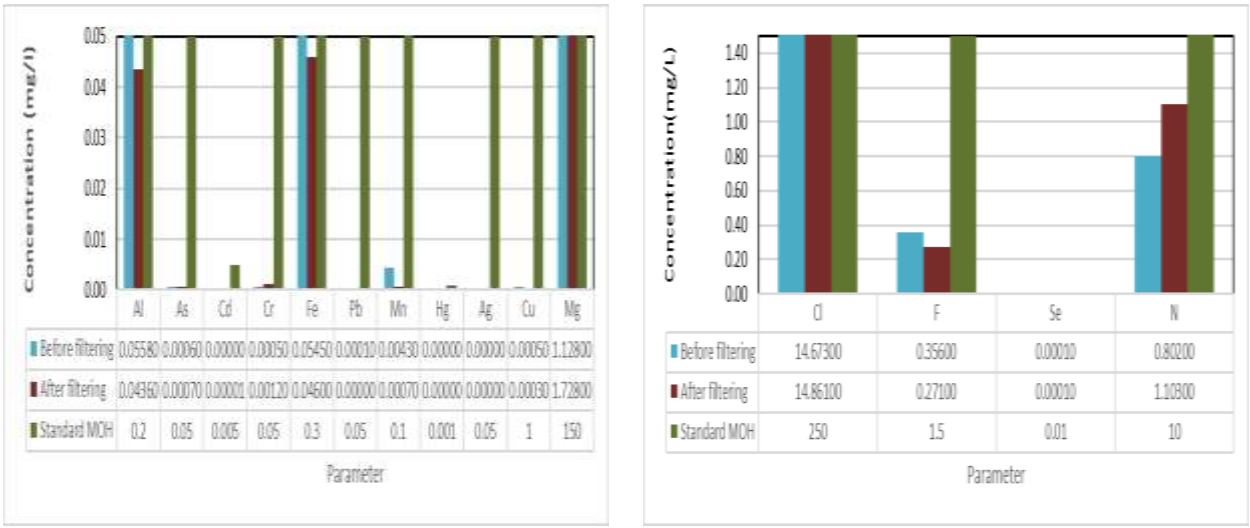
3.2.2 Brand A (Model 2)

Fig. 3 shows the experimental results of water before and after passing through a water filter system designer A, model 2 in Rengit, Batu Pahat. The water filter system is installed in 2016 and the latest date maintenance on 08/05/2017. The data show the percentage removal of manganese and lead parameter exceeds 84%. Whereas parameters such as aluminium, copper, fluoride, selenium and iron removal of a percentage value less than 43%. The possible effect of aluminium has developing Alzheimer's disease when significant amounts of aluminium in the brain tissue of Alzheimer's patients [23]. Furthermore, not all the water filter system units give the same expected result for the parameter of water quality after filtering. Based on the result obtained, the effective removal for the system is depends on the type of media filter, media size, filtration volume and cleaning water [24]. The mentioned filtration system is not able to remove the highest percentage removal of some parameter in drinking water after filtration but at least the total seven metal concentration level has been reduced. There is an increase in the concentration of arsenic, cadmium, chloride, chromium, magnesium and nitrate in the water after the filtration process. However, the concentration level for parameters increased after through water filter system still meet the Ministry of Health drinking water standards. Factors associated with heavy metal contamination in drinking water are the source of drinking water, leaching of the heavy metal from the corroded pipeline and unhygienic drinking water practice [25].



(a) **(b)**

Fig. 2 - (a) The cation heavy metals concentrations of water before and after through water filter system by brand A (Model 1), and (b) The anion heavy metals concentrations of water before and after through water filter system by brand A (Model 1)

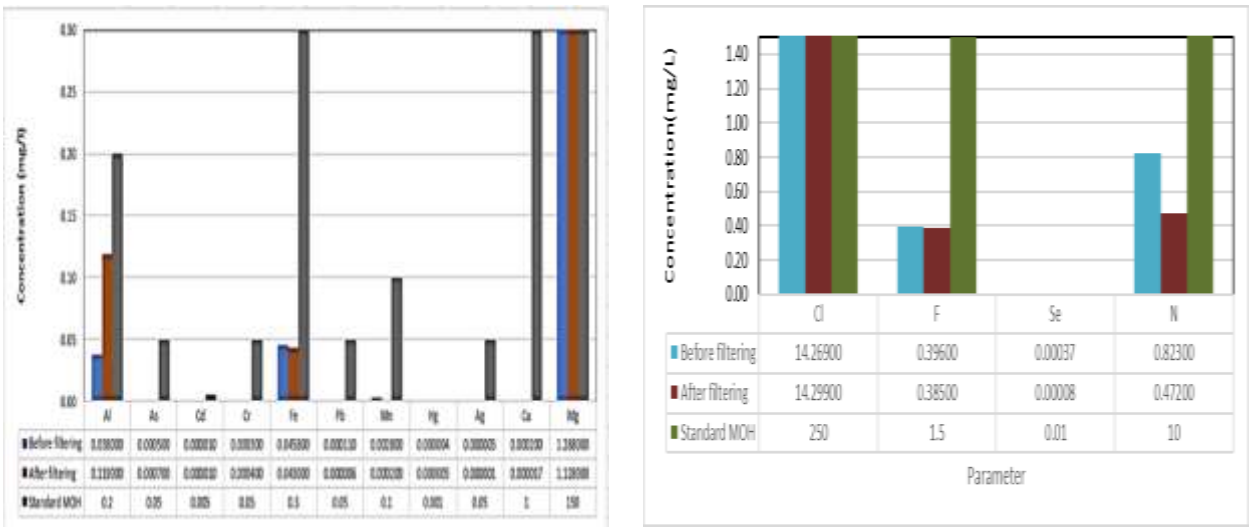


(a) **(b)**

Fig. 3 - (a) The cation heavy metals concentrations of water before and after through water filter system by brand A (Model 2), and (b) The anion heavy metals concentrations of water before and after through water filter system by brand A (Model 2)

3.2.3 Brand U (Model 1)

The results of water quality tests before and after the use of a water filter system U brand shows in Fig. 4. Location is on the water filter Rengit, Batu Pahat and June 2017 is the latest in system maintenance of the filter. Data shows the water quality before and after the water filter system is in compliance with the Ministry of Health drinking water standards. Percentage removal of more than 80% of the parameter copper, lead, silver, manganese and selenium. Meanwhile, in some heavy metals include copper, selenium and zinc are essential to maintaining the metabolism of the human body, but at higher concentrations will lead to poisoning human body [26]. While parameters such as aluminium, arsenic, chromium, mercury and chloride showed an increase in concentration after the filtration process. No significant reduction in the concentration of the fluoride, iron and magnesium. According to WHO, internal corrosion of pipeline can add heavy metals such as lead, copper and iron into drinking water [27]. The influence from types and conditions of pipes used in the distribution system might lead to the varying concentration in iron [28]. The household with old rusted iron pipes may experience a higher level in iron concentration as opposed to PVC pipes users [29].



(a) **(b)**

Fig. 4 - (a) The cation heavy metals concentrations of water before and after through water filter system by brand U (Model 1), and (b) The anion heavy metals concentrations of water before and after through water filter system by brand U (Model 1)

4. Summary

Public perception of the installation of water filter machines for household use can improve the quality of water based on the testimony of a producer shall be corrected with reference to scientific evidence verified by a third party. The guaranteed water quality water filter system manufacturer presented to the user can be assessed and approved by the authorities if there are guidelines that must be adhered to by the manufacturer. Results of preliminary studies for water quality before and after passing through a water filter system showed that the water quality meets drinking water standards of the Ministry of Health. There is some water quality of the water filter system under test showed the water quality before and after filtration gave no significant changes or improvements. On the contrary, parameters such as total chloride, nitrate, arsenic, chromium and mercury are harder to remove. Moreover, the major factor in the selection of water purifier machines is the price offered and the main information about the product is obtained through the advice of friends and neighbours. Besides that, other factors that need to be taken care to ensure the quality of water from the water purifier is in terms of periodic maintenance and the lifespan of the product. Based on the results, the respondents choose periodic maintenance every 2-5 months and 6-12 months is dominant compared to the respondents who had never maintained a water filter machine since its inception. This is because the monitoring of the water filter machine is vital to producing good water quality.

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