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Home Water Purification System in Malaysia: Qualitative and Quantitative Study

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Abstract. Concern over tap water quality has led to the expansion of water filtration system in Malaysia. This study is important to ensure that brands of water filters that have dominated the market in Malaysia do not exceed the quality of water released by safe water filters and no other pollutants leach from the machine. An exploratory study was undertaken to determine the pattern and selection factor of a home water filter system through a set of questionnaires. The survey results indicated that the most popular brands in Malaysia is Brand A from reverse osmosis filtration system. In the experimental study, five most frequently used brands of home water filters were evaluated and compared. Among the 27 parameters studied for each home water filter system, all parameter of physical, chemical and bacteriological quality is complied with the guideline values of the Ministry of Health Malaysia. Parameter of bacteriological quality shows absence bacteria parameter was detected in all samples tested. Meanwhile, physical quality parameter was given best performance removal from brand E and chemical water quality was efficient removal from brand C. In most cases user apply the home treatment of tap water to ensure that the quality of water physically look better and safe to be consumed.

1. Introduction

Water is the comprehensive dissolvable of our planet where both inorganic and natural issue used as a part of all procedures of living things is broken down or travels, dealing with the life of each and every living creature, including people [1]. Water question is unquestionably one of the primary factors that are related with the human improvement considering its effect on human lives.

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 to have installed a water filtration system at home. 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. This filter is used to hold the water impurities and produce clean water after filtering [2]. The effectiveness of the water filter system can be improved by attempting a mix of two or more treatment methods media for the complete and successful removal.

Various types of water filter systems are available in the Malaysian market using filtering media such as silica, sand, activated carbon, polypropylene, UF membrane, zeolite, fiber, fine woven fabrics [3]. Activated carbon filters is a material commonly used in water filtration systems as it is able to absorb various pollutants found in water such as pesticides, industrial chemicals, taste and odor [4].



Drinking water purposes by the used of solid adsorbents shows potential as one of the most efficient methods for the treatment and removal any contaminant in water [5].

Home water filtration system is needed for consumer to improve the public health and concern for water contamination [6]. In most cases the filtration systems were tested at the origin place on the capability to purify the water. Therefore, extensive study should be conducted for ensuring the most preferable brand by the consumer resulted to produce high quality of water after through filtration process. The theories and technologies principle were studied behind a few popular types of home water filter system available in Malaysian market. This result was conducted to identify the dominant water filter type in Malaysia by conducting a laboratory experiments on water quality parameters include physical, chemical and bacteriological test before and after through the water filters system. Therefore, this study is important to ensure that brands of water filters that have dominated the market in Malaysia do not exceed the quality of water released by safe water filters and no other pollutants leach from the machine.

2. Methodology

2.1. Secondary data collection.

The set of question forms was provided in the form of google form as the study instrument. This questionnaire form was opened within a certain period within 6 months of collection period. 140 numbers of respondents throughout Malaysia who give feedback on the questionnaire. The data was analysed and the selected brand of water filter system were conducted in laboratory experiments to check the quality water filter. 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 type of water source used
- iv. Why install the home water filter system
- v. The period for using a water filter machine
- vi. Are respondent satisfied with the quality of tap water in home
- vii. Are respondent satisfied with the water filter quality after install home water filter system
- viii. How many water filter machines are installed at home
- ix. How long respondent use water filter machine
- x. How often does a water filter machine be maintained
- xi. Where respondent get information about water filter system products
- xii. What is the primary factor that emphasized the consumer in the selection of water filters products

2.2. Analysis of water quality and filter media.

2.2.1. Sampling.

The water sample was collected in 1000 ml plastic bottles or glass bottles [7]. The water sample is taken directly from the pipe and after the water passed through the filter. All bottled sample was label with information such as type of samples, dates and times. All sampling bottles was acid washed prior to sampling. At the start of experimentation, water samples were collected after running the water for 5 minutes [8]. Sample bottles was fully fill with water samples to ensure the elimination of air bubbles and organic particulate matter entrapped in the bottles. The sample was stored in an icebox and transported back to the lab for analysis. Water samples was stored at 4°C before further analysis [7].

2.2.2. Method of test and analysis instruments.

Sampling, sample preservation and laboratory analysis was based on Standard Methods for the Examination of Water and Wastewater [7]. Table 1 shows all methods and equipment used in the testing of water quality.

Table 1. Equipments used in the experiment.

Equipment	Model	Analysis
pH meter	HACH Sension	pH measure
Turbidity meter	HACH 2100P	Turbidity measure
Atomic Absorption Spectrometer (AAS)	Perkin Elmer Analyst 800	Measure of magnesium and sodium
Inductively Coupled Mass Spectrometry (ICP-MS)	Perkin Elmer Elan 9000	Measure of aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, selenium, silver and zinc
Ion Chromatography (IC)	Dionex Ics- 2000	Measure of chloride, fluoride, nitrate and sulphate
Mercury Analyzer	MA 3000 RD/SC	Measure of mercury
DR 6000	HACH UV-Vis Spectrophotometer	Measure of colour, ammonia, phenol, cyanide, hardness, residual chlorine and anionic surfactant
Chromocult agar	-	Total coliform and Escherichia Coli

3. Results and Discussions

3.1. Survey analysis: Statistical results

From the survey results, respondent's distribution covers the entire state in Malaysia. Majority of household consumers are those who live at Malacca. Follow by Johor and Selangor.

The most popular types of water filter system used by consumers is Brand A with 50 respondents. The second commonly used water filter is Brand B with 45 respondents, followed by Brand C, D, and E with 20, 8, 6 respondents respectively. Table 2 presents that the properties and mechanism in the filter media. According to Table 2, the common filter media was used in each types of water filter system are activated carbon filter, sediment filter as sand filter and natural filter for example zeolite filter.

There are several reasons that the consumers choose to install Brand A and B as the dominant type of water filter. The main reasons are might due to its cheaper price and easiest unit to install compare to other types of water filters. Other study also revealed that consumers are more affordable to install this kind of water filter [9]. The first popular brand A is applying reverse osmosis system to produce reverse osmosis water to consumers. Through the reverse osmosis filtration system, it will filter up to 99.99% of bacteria and also suspended matter in the water. The disadvantage from these systems is about this filter eliminates the good minerals and bacteria that the body needs [10]. Furthermore, the second main brand is Brand B from the nano positive technology filter media to produce alkaline drinking water. This system is a water-stripping technology that filters out almost all the hazardous matter and hazardous suspended matter in the water by leaving only the useful bacteria and minerals salts needed by the body [11].

The water sources used in the water filter system are derived from tap water sources of water treatment plant. From the data, only two respondents used water filter system sources from groundwater and the case are from Perak and Kelantan.

Table 2. The properties and mechanism in the filter media.

Name of water filters	Types of water filters	Types of filter media in the systems
A	Reverse Osmosis Filtration System	Stage 1: Plus-sediment filter Stage 2: Pre-carbon filter Stage 3: RO membrane filter Stage 4 and 5: Post carbon and fine filters Stage 6: Ceramic filter
B	Nano Positive Filter	Stage 1: Sediment filter Stage 2: Pre-carbon filter Stage 3 to 5: Natural filter Stage 6: Nano-positive filter
C	Reverse Osmosis Purification System	Stage 1: Pre-sediment filter Stage 2: Sediment filter Stage 3: Organic granular activated carbon pre-filter Stage 4: Reverse Osmosis membrane Stage 5: Organic granular activated carbon post-filter
D	Water Purification Innovative Technology	i. Ultraviolet technology ii. Carbon filter technology iii. In one cartridge with an ultraviolet (UV) lamp inside a carbon block filter
E	Healthy Ionized Water	Stage 1: PP Polypropylene Stage 2: UF Membrane Stage 3: NSF GAC Carbon Stage 4: Japan UNITIKA filter Stage 5: Far infrared Stage 6: Electrolysis, Japan Platinum Baked Titanium

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Around 93% reported that the reasons for purchasing water filter system to ensure health. Less respondents (6%) agree that news and complaint about water pollution followed by influenced by friends and relatives. From the data shows that the Malaysian people is concern about the water supply as drinking water in human lives. According to study from [12], also stated that installing water filter

system seem to be health concerns, followed by perception of poor tap water quality and increasing contamination and pollution in the country.

States that 90% of the respondents are not satisfied with the supplied tap water and only 10% of the respondents are satisfied with the current supplied tap water. Quality of tap water is difference from one place to another place. Respondents indicated that yellowish color (74%), the second reasons is chlorine smell (14%) and followed by problem from suspended solid (5%) and skin problem (1%). Same data studies from [12], stated that respondents said that color, odor, and taste were the main problems with their tap water quality. Other than that, unsatisfied tap water might also due to the distribution system at home rather than efficiency of treatment process at the water treatment plants.

The most respondents (98%) reported that satisfied with the quality of drinking water after installing a water filter system. Only 2% of the respondents not satisfied. The reasons some consumers not satisfied with the water filter system have been install at home may due to several reasons such as the filtration system is not working well. Most of respondents are satisfied with water from filtration system is because the expected function of each water filter system by removal of odor, inorganic waste, chlorine, microbes, organic waste, pesticides and an added of mineral in drinking water [12].

The results 118 (84%) respondents of the total users have installed one unit of water filter, 22 (16%) respondents have installed two water filters and no respondents installed more than two units of water filter at home. From the study by [13], there are two types of water treatment systems that are currently available include Point-of-Use and the Point-of-Entry water filter. From this study, the result shows that most of water quality parameters at the house with POE and POU water filters shows a significant reduction as compared to other houses that has either a POU or POE water filter only [13]. This can conclude that the water quality parameters become more perform when two water filter is installing at home.

The most respondents used water filters within one to five years (51%). Other than that, the use of water filter system for over five years and less than a year is 44% and 5% respectively. The results show that, periodic maintenance every two to five months (43%) and six to twelve months (39%) is the dominant maintenance. While compared to the respondents who stated periodic maintenance period per month was 16% and 1% who had never maintained a water filter machine since its inception. The maintenance for water filter system is important to produce the good water quality. Previous study by [14], stated that the disease such as water borne come from unclean of drinking water.

In general, the dissemination of the primary information sources in the selection of water filters system is through friends or neighbour (31%), followed by information through salesman product (24%) and their own search on internet about the brand of water filter (18%). This is because they might be realized by friends and neighbour about the presence of the water filter machine is from the internet and 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 [12].

The selection factors of water filter system have shown that most respondents agree that the price (23%) offered by a water filter system is a major factor in the selection of the product. The services offered (20%), while the design and diversification of water filter system function (17%) are the second and third factors that are the respondent's choice. From the results, the price is the most demand part to select the water filter machine.

3.2. The analysis of water quality parameter.

3.2.1. Bacteriological quality: *Escherichia coli* and *coliform*.

The experimental result of microbiological test shows that none of the water filter brand samples had detectable *Escherichia coli* in the water filter before and after filtering. Thus, each of the water tested met the MOH standard safe drinking water criteria for absence of bacteria [14]. The results is in

agreement with [14], no *Escherichia coli* were detected at post-treatment in any of 320 samples of drinking water sources collected in developing countries. According to [13], was also found out that the house installed with both Point-of-Use (POU) and Point-of-Entry (POE) filters tend to provide the greatest reduction in *Escherichia coli* and total coliform. From the study by [15], it is shown that the removal of *Escherichia coli* and total coliform was found significant, which was supported by the reduction in diarrhoea cases observed by ceramic silver-impregnated pot filter users in a recent field study. The sources of coliform bacteria are due to re-growth in distribution systems, breakdown of the treatment barriers, due to corrosion control and also the availability of organic and inorganic nutrient [16].

3.2.2. Physical quality: Color and turbidity

Table 3. Summary results of physical water quality.

Parameter of chemical quality	Best removal of brand	Percentage removal	p-value for each brand		References
			Before filtration	After filtration	
Color	E	73.4%	$p > 0.01$	$p < 0.10$	[17,18]
Turbidity	E	94%	$p < 0.01$	$p < 0.01$	

Note: $p < 0.01$ -highly significant, $p < 0.05$ -significant, $p > 0.10$ -not significant [19].

Based on the results in this study and the previous study can be proved that the natural filter and membranes filter give a best performances percentage removal of physical contaminant in drinking water.

3.2.3. Chemical quality

Table 4. Summary results of chemical water quality.

Parameter of chemical quality	Best removal of brand	Percentage removal	p-value for each brand		References
			Before filtration	After filtration	
pH	C	The treatments of filtration can increase water to be more neutral after filter process	$p > 0.10$	$p < 0.05$	[20]
Hardness	E	67%	$p < 0.10$	$p < 0.10$	[21]
Ammonia	A and C	100%	$p > 0.10$	Same data	[22,23]
Manganese	B	60%	$p < 0.01$	$p < 0.01$	[22]
Cyanide	D	67%	$p < 0.01$	$p < 0.01$	[24]
Residual Chlorine	A and C	96% and 90%	$p < 0.10$	$p < 0.01$	[12, 25]
Nitrate	C	94%	$p > 0.10$	$p > 0.10$	[9]
Sulphate	C and A	99% and 98%	$p > 0.10$	$p > 0.10$	[20]
Aluminium	C and B	99% and 95%	$p < 0.05$	$p < 0.01$	[26]
Arsenic	C	93%	$p > 0.10$	$p > 0.10$	[14]
Cadmium	C and E	100% and 98%	$p < 0.05$	$p > 0.10$	[27]
Chloride	C	94%	$p > 0.10$	$p > 0.10$	-
Chromium	C	52%	$p < 0.05$	$p < 0.01$	[26]
Copper	A	97%	$p > 0.10$	$p < 0.01$	[28]

Table 4. Summary results of chemical water quality (cont.)

Parameter of chemical quality	Best removal of brand	Percentage removal	p-value for each brand		References
			Before filtration	After filtration	
Magnesium	C and A	95% and 93%	p < 0.01	p < 0.01	[13]
Fluoride	C	84%	p > 0.10	p > 0.10	[6,8]
Iron	C and A	100% and 91%	p < 0.05	p > 0.10	[13,29]
Lead	A, C and E	100%, 100% and 97%	p < 0.05	p > 0.10	[25]
Mercury	B and C	100%	p > 0.10	p > 0.10	-
Selenium	C and A	99% and 98%	p > 0.10	p > 0.10	-
Silver	A, C and D	98%, 94% and 90%	p < 0.01	p > 0.10	-
Sodium	C	85%	p < 0.01	p < 0.01	-
Zinc	A and C	98% and 94%	p > 0.10	p < 0.01	[13]
Phenol	D	25%	p > 0.10	p > 0.10	[24]

Note: p < 0.01-highly significant, p < 0.05-significant, p > 0.10-not significant [19].

4. Conclusion

It is hoped that the output of the research will produce significance finding to be adopted by Ministry of Health Malaysia in ensuring home filter system will be closely monitored by the government for safety and health. The main factor in the selection of water filter systems is the cost offered by the supplier and main data about the water filter system is acquired through influence by advice of friends and neighbors respond. Ensure the drinking water quality through filtration process can be ensured, assessed and approved by the Ministry of Health and other authorities if there are guideline that must be followed by all manufacturer of home water filtration systems. Results of experimental study for water quality parameters testing before and after passing through a water filter system showed most of the parameters meets drinking water quality by MOH except for some parameters do not show a better removal. Among five brands that were investigated in this study, brand C is the best performance removal of reverse osmosis membrane purification system with five stage filter media in the systems. The quality and effectiveness of each home water filter system can be identified from the usage pattern by the filter media in each filter system.

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