

The Study of Water Quality in UTHM Residential College Pagoh by Filtration Process

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DOI: <https://doi.org/10.30880/mari.2023.04.04.003>

Received 01 September 2023; Accepted 15 October 2023; Available online 01 December 2023

Abstract: This article investigates the domestic water supply quality in UTHM Pagoh Residential College after filtration process. Generally, humans require clean water to consume in order to prevent the adverse health effects produced by pollutants in water. Therefore, water treatment is required to obtain clean water. One of the water treatment processes is filtration. The objectives of this study are to produce a water filter which consists of fine sand and crushed cockle shell with analysing the results of pH test, Biochemical Oxygen Demand (BOD) test, Total Suspended Solid (TSS) test and Ammoniacal Nitrogen (NH₃-N) test on the filtered water. Fine sand and crushed cockle shell are used as the main composition for the drinking water filter. Three different filters has been used in this study. The composition of Filter A consists of 0.5 kg of fine sand only. Filter B consists of 0.5 kg of crushed cockle shell. Filter C consists of 0.25 kg of fine sand and 0.25 kg of crushed cockle shell. All of the filter layers are installed within the hose and the quality of water is recorded. From the parameter test, we know that quality of filtered water is better than ordinary pipe water.

Keywords: Water Quality, Fine Sand, Crushed Cockle Shell, Filtration, Water Quality Parameter

1. Introduction

Water is defined as the comprehensive dissolvable of the earth. The clean water resources are definitely the most crucial assets of any human civilization. According to World Health Organization (WHO), access to safe drinking water can result in tangible benefits to health [1]. Water in Malaysia is treated in two stages. The wastewater treatment is selected during the first stage. It aims to treat the wastewater from the toilet or human discharge before the water flows into the stream. The second

process is treatment of water from the rivers and lakes. The river water is treated in water treatment plant to free the water from suspended solids and dangerous microorganisms.

Water filter is defined as a device which involves the process of removing or reducing the concentration of particulate matter, including suspended particles, bacteria and algae. It will ensure the filtered water is safe to use for certain purpose such as drinking, medical and pharmaceutical applications. The handmade water filter consists of two layers which are fine sand and crushed cockle shell. Our study break the mould in which we install the filter layer directly into the hose instead of constructing a water filter model like others has done such as Cuckoo and SK Magic.

The objectives of this study is to produce a water filter which consists of fine sand and crushed cockle shell and to analyse the results of pH test, BOD test, TSS test and NH₃-N test of the filtered water. All of the parameters will be evaluated based on the laboratory test and the quality of water can be classified according to the Malaysia Drinking Water Quality Standard (MDWQS).

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of this study.

2.1 Materials

The raw materials used in this study are fine sand and crushed cockle shell. Sand is a granular substance made up of finely divided rock and mineral particles. Sand comes in a variety of compositions, but its grain size is what distinguishes it. Sand grains are finer than gravel grains and coarser than silt grains. Sand can also refer to a textural class of soil or a type of soil, such as one that contains more than 85% sand-sized particles by mass. Fine sand is defined as a sand soil texture with a particle size range of 0.05 mm (sieve size 270) to 0.25 mm (sieve size 60) [2]. The size of fine sand used after dry sieve is 0.6 mm.

A cockle is a marine bivalve mollusk that is edible. Although many small edible bivalves are referred to as cockles, true cockles are members of the Cardiidae family. Cockles can be found on sandy, sheltered beaches all over the world. When viewed from the end, the distinctive rounded shells are bilaterally symmetrical and heart-shaped. Most, but not all, genera have a shell with numerous radials, evenly spaced ribs (for an exception, see the egg cockles, which have very smooth shells). In usage of filtration, cockle shell will remove the compound that was odorous in matter which are physical and chemical for waste water treatment. The cockle shell will remove Sulphur compound in about 99% efficiency [3]. The size of crushed cockle shell used after dry sieve is 0.6 mm.

2.2 Methods

Methods section consist of preparation and testing of samples.

2.2.1 Preparation of Water Filter

Water filters are used by hikers, aid organizations during humanitarian emergencies and the military. These filters are usually small, portable and lightweight. Procedures in preparing a water filter are as follow. First and foremost, inserted fine sand into the water hose. Then, tighten the hose at both end with the clips to avoid the sand flowed out of the water hose during the filtration process. After that, started filtering the water by attaching the end of the water hose to the source of water as shown in **Figure 1**. Finally, repeated the process by replacing the fine sand with crushed cockle shell and also the combination of fine sand and crushed cockle shell into the water hose. The hose is placed horizontally during the filtration process.



Figure 1: Water hose attached to the source of water

There are three types of water filter prepared in this study as shown in **Table 1**.

Table 1: Type of Water Filter

Type of Water Filter	Material	
	Fine Sand (kg)	Crushed Cockle Shell (kg)
A	0.5	0
B	0	0.5
C	0.25	0.25

2.2.2 Testing of Samples

There are four test to be implemented for identifying the drinking water quality which are pH test, Biochemical Oxygen Demand (BOD) Test, Total Suspended Solid (TSS) Test and Ammoniacal Nitrogen (NH₃-N) Test. For pH Test, this test will show the water is acidic, neutral, or alkaline. The U-50 Multiparameter Water Quality Meter used to evaluate both filtered and unfiltered water. Half of a 1000 mL beaker was filled with water samples. The probe of the U-50 Multiparameter Water Quality Meter will be submerged in the beaker. The result of water will be displayed immediately by the U-50 Multiparameter Water Quality Meter [4]. Besides, for Biochemical Oxygen Demand (BOD) Test, BOD test is a typical environmental method for assessing how much oxygen is available in a sample to support microbiological life. Many environmental laboratories use the BOD tests to analyse waste water, compost and sludge. The test is commonly referred to as a five-day BOD since it is conducted over a five-day period, or a *BOD*₅ [5]. Furthermore, for Total Suspended Solid (TSS) Test, TSS test is a test to determine how much portion of total solids is retained after filtration. To measure TSS, the water sample is filtered through a pre-weighed filter. The residue retained on the filter is dried in an oven at 103–105°C until the weight of the filter no longer changes. For Ammoniacal Nitrogen Test, NH₃-N test is a measure for the amount of ammonia, a toxic pollutant often found in landfill leachate and in waste products, such as sewage, liquid manure and other liquid organic waste products.

3. Result and Discussion

The result and discussion in this section presents data and analysis of this study based on the test carried out.

3.1 pH Test

Table 2 shows the data about the pH analysis of drinking water sample which are obtained from the unfiltered and filtered water. According to Malaysia Drinking Water Quality Standard (MDWQS), the limit standard for pH value is between ranges of 6.5 to 9.0. The pH value of water samples must be evaluated because if it is less than 7.0, it is acidic, and if it is greater than 7.0, it is alkaline. Corrosion of metal pipes and plumbing systems is another impact that can occur when the pH value is acidic. From the **Table 2**, the average pH value of four different drinking water samples is ranged between 6.33 to 7.56. The unfiltered water has the lowest average pH value, which is 6.33 whereas the water filtered with sand and crushed cockle shell has the highest average pH value, which is 7.56. It can be concluded that the overall drinking water samples are in neutral state as the value is not lower than pH 7 except the unfiltered water. Water is acidic or alkaline can be identified by using our senses, such as taste or touch. For example, if the pH of the water samples is higher, the water has a slippery feel and may taste like baking soda, which can cause deposits on fixtures; if the pH is lower, the water tastes bitter or metallic, which can cause fixture corrosion. Value of pH can be used as a criterion for determining how corrosive water is. Furthermore, pH can change the degree of metal corrosion and disinfection efficiency in plumbing systems, which may have an impact on health due to increased metal consumption. Consumers should be concerned about pH values since they can affect health risks, even if they do not have a direct impact on them. As previously stated, the pH value of the selected residential colleges does not exceed the requirement, indicating that the waters are safe to drink.

Table 2: pH Analysis of Water Samples

Water Sample	pH value			Average pH value
	Sample 1	Sample 2	Sample 3	
Unfiltered Water	6.32	6.35	6.33	6.33
Water Filtered with Sand	7.02	7.02	7.02	7.02
Water Filtered with Crushed Cockle Shell	7.23	7.25	7.24	7.24
Water Filtered with Sand and Crushed Cockle Shell	7.56	7.56	7.55	7.56

3.2 Biochemical Oxygen Demand (BOD) Test

The BOD₅ analysis of four drinking water samples is shown in **Table 3**. MDWQS does not have any defined limitations, although it does have a value of 6 mg/L for recommended raw water quality. BOD, also known as the quantity of dissolved oxygen (DO) necessary for the biochemical decomposition of organic compounds and the oxidation of some inorganic elements, is a means to determine whether there is contamination of organic material in water. Furthermore, BOD₅ is linked to DO since it can provide both direct and indirect information, such as bacterial activity and photosynthesis. The average BOD₅ values for the water samples range from 0.65 mg/L to 4.59 mg/L, as indicated in the **Table 3**. The numbers are also not even close to the limit for raw water quality except the unfiltered water, indicating that it is in good working order. As BOD₅ levels are high, DO levels will decrease because of the oxygen that is available in the water is being consumed by the bacteria. Because there is not enough DO in the water, organisms in the water may perish. However, if the BOD₅ level is low, the DO level rises, indicating that the water is of good quality and unlikely to affect human health. Water filtered with sand and crushed cockle shell has the lowest average BOD₅ value which is

0.65 mg/L whereas the unfiltered water has the highest average BOD₅ value, which is 4.59 mg/L. This means the water need to be filtered before consuming it.

Table 3: BOD Analysis of Water Samples

Water Sample	BOD (mg/L)			Average BOD (mg/L)
	Sample 1	Sample 2	Sample 3	
Unfiltered Water	8	3.33	2.45	4.59
Water Filtered with Sand	3	2.33	1.09	2.14
Water Filtered with Crushed Cockle Shell	2	1	0.82	1.27
Water Filtered with Sand and Crushed Cockle Shell	1	0.67	0.27	0.65

3.3 Total Suspended Solid (TSS) Test

Table 4 shows the analysis of drinking water samples. According to MDWQS, the limits for TSS value is 25 mg/L. Based on **Table 4**, value for TSS of drinking water samples are between 10 mg/L to 20 mg/L which show it does not exceed the limit standard. If the value for TSS is less than 1000 mg/L, it could be considered the water samples as fresh water. This demonstrates that the tap water in the research area is safe to drink after filtration. As a result, it can be determined that the water samples are safe to drink and do not constitute a health risk to the residents. The unfiltered water has the highest average total suspended solid, which is 30.67 mg/L whereas the water filtered with sand and crushed cockle shell has the lowest average total suspended solid which is 8 mg/L. The result for each filtered water is much better compared to unfiltered water. That's means the water in residential college need to be filtered before consuming it.

Table 4: TSS Analysis of Water Samples

Water Sample	Total Suspended Solid (mg/L)			Average Total Suspended Solid (mg/L)
	Sample 1	Sample 2	Sample 3	
Unfiltered Water	32	28	32	30.67
Water Filtered with Sand	20	20	20	20
Water Filtered with Crushed Cockle Shell	16	20	16	17.33
Water Filtered with Sand and Crushed Cockle Shell	8	8	8	8

3.4 Ammoniacal Nitrogen (NH₃-N) Test

Table 5 shows the data of NH₃-N concentration of the drinking water samples. There is no specific guidelines value for ammoniacal nitrogen concentration, but it does stipulate that the one for drinking water standard is 0.5 mg/L. So, NH₃-N is a measurement for the amount of ammonia, a toxic pollutant often found in landfill leachate and in waste products, such as sewage, liquid manure and other liquid organic waste products. The term is used widely in waste treatment and water purification systems. Ammonium is the predominant form when the water pH is below 8.75, whereas ammonia is the predominant form when the pH is above 9.75 [6]. The unfiltered water has the highest value of NH₃-N concentration, which is 0.08 mg/L NH₃-N whereas the water filtered with sand and crushed cockle shell has the lowest value of NH₃-N concentration, which is 0.03 mg/L NH₃-N. As such, it is obvious that

the water filtered with both elements is the safest to drink by the residential college's people. Ammonia can also reduce disinfection efficiency, raise oxidant demand, cause manganese removal filters to fail, corrode copper alloy pipes and fittings. Furthermore, nitrification, which results in the creation of nitrites and nitrates, is a serious concern with ammonia in drinking water. Nitrite is the intermediate oxidation state between ammonia and nitrate and can be formed by the reduction of nitrates under conditions where there is a deficit of oxygen. It is dangerous because it will react in the strongly acidic environment of the stomach to form nitrosamines which are carcinogenic and have been linked with bowel cancer. Nitrates are a set of compounds that involve nitrogen and oxygen molecules. High level of nitrates in human body will turn skin to a bluish or gray color and cause more serious health effects like weakness, excess heart rate, fatigue and dizziness.

Table 5: NH₃-N Analysis of Water Samples

Type of Water Sample	NH ₃ -N Concentration (mg/L)			Average of NH ₃ -N (mg/L)
	Sample 1	Sample 2	Sample 3	
Unfiltered Water	0.08	0.08	0.08	0.08
Water Filtered with Sand	0.06	0.06	0.06	0.06
Water Filtered with Crushed Cockle Shell	0.05	0.05	0.05	0.05
Water Filtered with Sand and Crushed Cockle Shell	0.03	0.03	0.03	0.03

4. Conclusion

This study has fulfilled the objectives as to produce a water filter which consists of fine sand and crushed cockle shell and to analyse the result of pH test, BOD test, TSS test and NH₃-N test on the filtered water. Based on the analysis results obtained via the experiments, all of the parameters (pH, BOD, TSS and NH₃-N) do not exceed the limits that stated in MDWQS which make the filtered water for UTHM Pagoh Residential College is safe to drink and will not affect the consumers' health. This study gives a huge contribution to people as these filters can develop clean water to be used for daily activities. Knowing the water quality can help us avoid getting sick. Moreover, the water treatment can be conducted to get the better quality of water [7]. For recommendation, the person-in-charge can perform routine maintenance, such as cleaning or replacing water in the water tank of each residential college, as the water tank is the major source of distribution water for each house in the structures. Besides, the management of the residential college must ensure that every house has inhabitants in order to ensure that water is continuously flowing via the tap water and contamination does not remain in the pipeline systems.

Acknowledgement

The authors would also like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

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