Journal of Critical Reviews

ISSN- 2394-5125 Vol 7, Issue 8, 2020

SURFACE WATER TREATMENT BY USING BIOSAND FILTER AND HIBISCUS ROSA SINENSIS LEAVES AS HEAVY METAL ADSORPTION IN KANGKAR SENANGAR'S RIVER, JOHOR

Nuramidah Hamidon[1], Siti Hajar Yahya[2], Norshuhaila Mohd Sunar[3], Mimi Suliza Muhamad[4], Hasnida Harun[5], Hazren Hamid[6], Ali[7]

[1,2,3,4,5,6,7]Department of Civil Engineering Technology, Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, KM, Jalan Panchor, 84600 Pagoh, Johor, Malaysia
Email: [1]nuramidah@uthm.edu.my

Received: 20.05.2020 Revised: 17.06.2020 Accepted: 06.07.2020

Abstract
Water is our most precious natural resource. In this case study which is in the Kangkar Senangar Johor, many rural communities also drink surface water which does not meet the required quality standards, causing serious health problems. From the interview with the Village Head, they also didn't have enough source of water supply. They only use groundwater as their water source to complete daily life task. Hibiscus Rosa Sinensis (HRS) leaves, as one of the well-known plant agricultural waste, a natural adsorbent, to remove iron (Fe) from aqueous solution by adsorption was investigated. In the present study, the potential adsorption of heavy metal was tested by different amount of adsorbent dosages as the factor affecting adsorption. Characterization of adsorbent was done by the means FTIR analysis to observe for the functional groups available on the adsorbent. Sorption was most efficient by using 0.60g of dosage with 200ml of water sample that taken from Kangkar Senangar's river at contact time of 20 minutes. After adsorption, the water sample will be treating by Biosand Filtration (BSF). The function of BSF is to reduce the turbidity, changes of the colour of water sample, increase the pH and dissolved oxygen. The BSF will filter all the suspended matter in the water sample after adsorption.. Based on the result produced, the hypothesis was achieved. Overall, the highest adsorption of Fe by HRS leaves was 85.62% which when the 0.80g of adsorbent was added during week 2. In conclusion, the result showed that the average adsorption of Fe in each week achieved in a range of 70 to 80%. This proved that Hibiscus Rosa Sinensis leaves was an effective natural sorbent.

Keywords--- Adsorbent, Biosand Filtration, Hibiscus, Iron

DOI: http://dx.doi.org/10.31838/jcr.07.08.284

INTRODUCTION

Water is our most precious natural resource. Clean water in many populated areas of the world is becoming a limited resource. Worldwide water demand is increasing day by day due to industrial and population growth[1]. As we observed, the shortage clean water supply being read and heard from media social or print media. Malaysia is facing this problem in the urban or rural area even Malaysia is a developing country that will become a developed nation. Early 20th century, many parts of the country were rural in nature and these areas obtained their water in the traditional ways such as rivers, wells, lakes and rain water collected from roofs of houses.

We are increasingly becoming aware of the importance of water to our survival and its limited supply, especially in such a rural area like Kangkar Senangar, Johor. Geographical location is the biggest reason why Kangkar Senangar facing this situation. The resident's houses in Kangkar Senangar are isolated and cause the pipeline cannot reach the house. Most of the population prefer to share resources in communities such as wells and river due to the expectation to get treated water is getting thinner after more than 40 years of waiting and hope.

Tube well water in Kangkar Senangar is an important resource for water supply. Water used for household purposes for food preparation or bathing. Tube well water also is an essential resource because we need water to drink. Basically, tube well water is exposed to several contaminants especially due to its high concentration of heavy metals. The cleanliness and safety of the water is a bit dubious and can lead to water pollution if untreated. Heavy metals are considered extremely harmful because they can cause illnesses, disorder and diseases to human. The improper disposal of heavy metals leads to pollution. There are 20 metals which are almost persistant and cannot be degraded or destroyed. From an ecotoxicoligal point of view, harmful heavy metals are mercury (Hg), lead (Pb), cadmium (Cd), chromium (Cr [VI]), zinc (Zn), arsenic (As), nickel (Ni) etc. Such heavy metals can lead to severe effects such as developmental problems, damage to vital organs, brain damage, cancer and also disability in certain cases [2]. Therefore, the water that containing heavy metal should be treated to produce treated water of the right quality and meet water quality guidelines in order to ensure effective protection of public health. The water should be free of harmful microorganisms or harmful levels of chemicals.

LITERATURE REVIEW

Water supply and quality in rural area

In poor countries, water supply infrastructure and services often lack proper management and supervision in the rural communities. Centralized treatment systems are usually unaffordable due to remote locations and lack of financial resources and skilled professionals[3]. Water supply for household interest such as drinking water, bath water and other necessities must meet the specified requirements of the World Health Organization (WHO) or national or local regulations.

Normally, the people used ground waters are the resident that lives near the groundwater to replace the piped water supply. However, not all the area receives a piped water supply and some of the rural area using groundwater as a daily water intake to replace the scarcity of clean water treated by the treatment plant. In Malaysia, the government will ensure that treated water is received from a source of water from the folk. Without treatment, water source raw water contains microorganisms like bacteria, heavy metals, dirt, and other impurities.

Adsorption

Adsorption is a method of phase transfer, commonly used in practice to extract substances from phases of fluids (gases or liquids). It can also be discovered in various environmental compartments as natural process. The more common definition defines adsorption as an accumulation of chemical species from a liquid phase on a liquid or solid surface. Adsorption has proven to be an excellent way of treating industrial waste effluents in water treatment, offering significant benefits such as low cost, availability, profitability, ease of use and efficiency[4]. It is also has been proved as an efficient removal process for a multiplicity of solutes. By adsorption to solid surfaces, the molecules or ions are removed from the aqueous solution.

A surface represents the outer or upper limit of a solid or liquid object, where bulk properties are no longer sufficient to describe the properties of the system. Adsorption is also a well-known process for separating the equilibrium and is an effective method for water decontamination applications. In terms of initial cost, flexibility and design simplicity, ease of operation and insensitivity to toxic pollutants, it has been found to be superior to other water re-use techniques. Adsorption also does not result in the formation of harmful substances[5]. There are two types of adsorption which are physical and chemical adsorption.

Plant biomass as adsorbent

Leaf

The leaf material is abundant, generally non-toxic, renewable plant material that can be easily and economically obtained. Leaf biomass has been explored for its potential as biosorbents for wastewater metal removal (Table 2.1). As a bio-adsorbent, leaf biomass is abundant, available naturally, and cost-effective in the biosorption of toxic elements. Leaf powder was considered suitable for removal of Hg(II).

Figure 2.1 Hibiscus rosa sinensis

Table 2.1 Leaf biomass adsorption capacity for heavy metal removal in aqueous solution

Leaf biomass	**Metal**	**pH**	**Adsorption capacity (mg/g)**	**References**
Pine leaves	*As(V)*	4	3.27	Shafique et al. (2012)
Loquat leaves (Eriobotrya japonica)	Cd(II)	6	29.24	Al-Dujaili et al. (2012)
Loquat ash (Eriobotrya japonica)	Cd(II)	6	21.32	Al-Dujaili et al. (2012)
Moringa oleifera (CAMOL)	Cd(II)	5	171.37	Reddy et al. (2012)
Moringa oleifera (CAMOL)	Cu(II)	6	167.90	Reddy et al. (2012) Reddy
Moringa oleifera (CAMOL)	Ni(II)	6	163.88	Reddy et al. (2012)
Neem leaves	*Cr(V)*	2	67.97	Babu and Gupta (2008)
Hibiscus rosa sinensis dye waste (HDW)	Pb(II)	6	90.90	Vankar et al. (2010)
Sunflower leaves	Cu(II)	5-6	89.37	Benaïssa and Elouchdi (2007)

Biosand Filter

The Biosand Filter (BSF) is one example of a feasible technique to produce drinkable water in rural area. The BSF is a downscaling of the Slow Sand Filtration (SSF) system for intermittent household water filtration. It has been stated that the BSF is effective in eliminating chemicals (e.g. iron, manganese and sulphur), pathogens (e.g. bacteria, viruses), and low turbid water turbidity. The filter can be made easily because it is built using materials that are available everywhere in this world. The components of BSF are concrete or plastic container that contain of selected prepared sand and gravel.

METHODOLOGY

Collection of water sample

The water sample will be taken by using grab sampling method. A properly taken grab sample is a snap shot of the quality of the water at the exact time and place the sample was taken. The water samples may be taken by simply throwing buckets tied to the ropes into the river since the sampling point is a high bridge. Then slowly lift up the buckets to keep yourself safe. After that, transfer the water sample taken from the buckets into the storage container. The sample containers must be clean and free from interference. Label the time, date and location of the water sample taken on the storage container. For this study, the water samples were taken for 4 weeks. The sample was taken in every week. Each week consist different weather's condition.

Preparation of Hibiscus Rosa Sinensis leaves as adsorbent

Huge amounts of Hibiscus Rosa Sinensis leaves wastes were obtained on road sides, streets and households. These leaves were collected and washed thoroughly with water several times with deionized water to remove adhering impurities from the surface. The washed material was dried in the oven at $80^{o}C$ until they reached a constant weight, which was accomplished after 48 hours (hrs).

Characterisation of Hibiscus Rosa Sinensis leaf

Fourier Transform Infrared (FTIR) spectroscopy

The adsorption characteristics of an adsorbent are predominantly influenced by the surface functional groups which were determined from the Fourier Transform spectroscopy analysis and presented by the FTIR spectrums. Analysis of FTIR spectrum provides information about the molecular structure of the functional groups present on the samples under investigation. Usually simple spectra are obtained from samples with few IR active covalent bonds whereas a complex spectrum gives more adsorption bands. The FTIR analysis for this study was held in Analytical Laboratory, Department of Chemical Engineering Technology (JTKK) UTHM Pagoh Campus.

Preparation Biosand Filtration as filtration method
Preparation Biosand Filtration material
The component of Biosand Filter is list in Table 3.1.

Table 3.1. The components of bio sand filter with their functions

Components	Functions
Lid	*Tightly fitting lid prevents contamination and unwanted pests.*
Diffuser	Prevents disturbing the filtration sand layer and protects the biolayer when water is poured into the filter.
Filtration sand layer	Removes pathogens and suspended solids
Coconut coir	Acts as adsorbent and holding high capacity of water
Outlet tube	Required to conduct water from the base to the outside of the filter
Filter Body	Holds the sand and gravel layers
Separating Gravel Layer	*Supports the filtration sand and prevents it from going into the drainage layer and outlet tube*
Drainage Gravel Layer	Supports the separating gravel layer and helps water to flow into the outlet tube

Preparation coconut coir
Coconut coir dust (also known as coco peat, coir waste or fibre dust) consists of short spongy fibres and dust which are a by-product in the processing of husk to coir fibre. The coconut coir can quickly reabsorb water even when completely dry. It has greater holding water capacity which is good for bio sand filter. The coconut coir that acts as adsorbent will be placed in the biosand filter after the filtration sand. The coconut coir is easier to obtain in Malaysia since Malaysia has a lot of coconut tree and most of the Malaysian food use coconut as the ingredient. To adsorb the heavy metal, the coconut coir dust was soaked in de-ionized water for 3 days and washed several times with water until all the coloured extract was removed and clean water obtained. It was oven dried at 60°C for 24 h.

Preparation of filter
Sieve analysis test
Sieve test is conducted by hand or using table-top Sieve Shaker to import the necessary shaking, rotating or vibrating motion. The aggregates are removed from operator once the optimum conditions have achieved and the result have been determined. The first step taken to do sieve analysis of biosand filtration is by put the sand and gravel through the 10 mm sieve. Throw away any rocks that stay on top of the 10 mm sieve. This is because they are too big to use in the biosand filter. Then pick up all the material that went through the 10 mm sieve. Put it through the 5 mm sieve. Store all the gravel that stays on top of the 5 mm sieve in the 5-10 mm gravel storage pile. This pile is used for two things: large gravel when make the concrete and drainage gravel that goes inside the filter. Pick up all the material that went through the 5 mm sieve. Put it through 0.6 mm sieve. Store all the gravel that stays on top of the 0.6 mm sieve in the 0.6-5 mm gravel storage pile. This is the separation for inside the filter. Store all the sand that fell through the 0.6 mm sieve in the < 0.6 mm sand storage pile. This is the filtration sand for inside the filter.

Biosand Filter design
The components of a generic bio sand filter are a plastic vessel filled with the filter media and gravel. The size of the filter was scaled down to ensure that the filter would not take up too much space in a small rural. The bio sand filter with sand has six distinct sections. The first section is an inlet reservoir through which contaminated water is poured into the filter. A standing water level is the second section and it facilitates the formation of the biological section by allowing oxygen to diffuse through to the biolayer.

The third section consists of fine sand with a particle size of ≤ 0.6 mm, packed to a height of 5 cm. This section is also known as the Schmutzdecke. It develops after use from one to two weeks to a couple of months as microorganisms, organic and inorganic materials from the inlet water are removed. The fourth section consists of the coconut coir that height of 2.8 cm. The fifth section consists of coarse sand with a particle size 0.6 mm – 5 mm as separating gravel layer and last section is gravel with a particle size 5 mm – 10 mm as drainage gravel layer. This section supports the filter media and helps water flow into the outlet pipe without removing the sand from the filter.

RESULTS AND DISCUSSIONS
Characterisation of adsorbent
FTIR Analysis

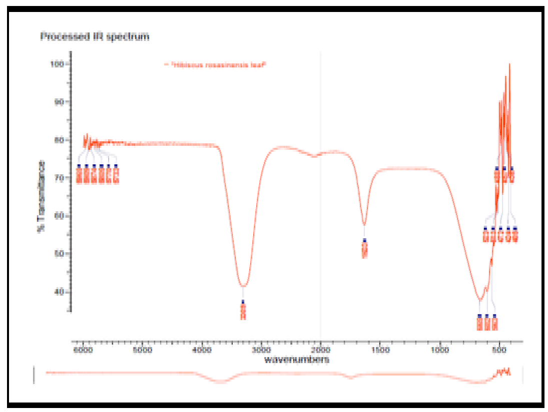

Figure 4.1. The FTIR Spectrum of Hibiscus Rosa Sinensis leaves after adsorption process

The peaks were located at 3309 and 1633 cm-1 observed from Figure 4.1 are characteristic of Hibiscus Rosa Sinensis leaves. The carboxyl(C=O), hydroxyl(O–H) and amines(–NH3) groups are claimed as well as hydrogen bonding, which were the preferred groups for the adsorption process exist in FTIR spectrum of HRS leaves. Based on the result, it was clearly shown that the wide and intense peak located at 3309 cm-1 corresponded to the stretching vibrations of –OH and –NH3 groups. The peak might be attributed to the physically adsorbed water molecule or result from hydroxyl and tertiary amines groups on the samples.

There is no spectrum for tertiary amines groups in Figure 4.1 because it is overlap with the O-H spectrum, which is found in the same range, 3309 cm-1. The medium intense band at 1633cm-1 is observed for the C=O amide stretching vibration in the FTIR spectrum of HRS leaves, indicating the existence of –CONH3 groups. The higher frequency absorption (1680- 1630) is called the Amide I band. In concentrated samples this absorption is often obscured by the stronger amide I absorption, which is at 1633 cm-1. Hence, results showed that only O–H, –NH3 and C=O groups were involved during adsorption process for HRS leaves.

Batch adsorption studies
Effect of dosages on Iron (Fe) removal

Table 4.1. The initial concentration of Iron in water sample for 4 weeks

Week	Weather's Condition	Initial Iron(Fe) Concentration (mg/L)
Week 1	Sunny day and no rain	0.71
Week 2	Heavy rainfall	1.46
Week 3	Rainy	1.21
Week 4	Sunny day and windy	1.24

The effect of dosages was investigated by contacting 200 mL of water sample with different amounts of adsorbents (0.20,0.40,0.60 and 0.80 g) for a contact time of 20 min at a temperature of 27± 0.5ºC, a shaking speed of 200 rpm and optimum pH of 6.0 (Table 4.1). After equilibrium, the samples were allowed to settle for some time after which the supernatant solutions were collected and analyzed. The effect of adsorbent dosage's result is shown in the Figure 4.2.

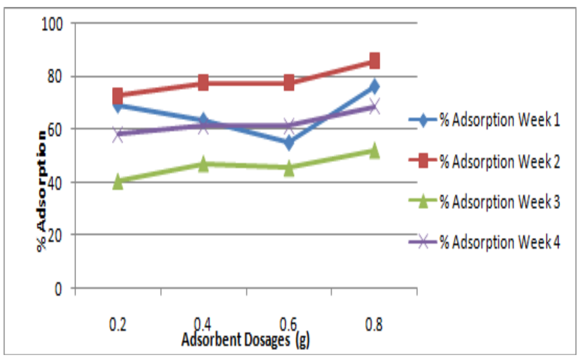

Figure 4.2. The graph of effect of adsorbent dosage on the adsorption of Fe onto Hibiscus Rosa Sinensis (HRS) leaves at room temperature; pH = 6; stirring speed = 200 rpm and time = 20 min

An increasing amount of Hibiscus Rosa Sinensis (HRS) leaves may be able to fully adsorb heavy metal Iron or reach an equilibrium state when reaching a plateau at a fixed concentration of matal. Percentage of Fe at differeent concentration of metal. Through Figure 4.2, it is showed that the increasing mass of HRS was able to adsorb considerable percentage of Iron in Kangkar Senangar's river. During week 1, the initial concentration of Fe is 0.71 mg/L which the lowest compare to another week. The adsorption increased as the amount of HRS increased. The highest adsorption for week 1 was when 0.80 g of HRS was added. The percentage adsorption was 76.06%. The lowest removal of Fe is when 0.60 g of HRS was added. The percentage adsorption was 54.93%. The weather's condition in week 1 was sunny day and no rain.

During week 2, the initial concentration during that week was 1.46 mg/L which the highest compare to another week. This is because that was a heavy rain season for that week. After adsorption and filtration process, the adsorption of Fe was increased. The highest adsorption for week was when 0.80 g of HRS was added. The percentage adsorption was 85.62%. The lowest removal of Fe is when 0.20 g of HRS was added. The percentage adsorption was 72.6%.

During week 3, the weather was rainy and light rain before the water sample was taken. The initial concentration of Fe during that week was 1.21 mg/L. The adsorption of Fe was the highest when the amount of 0.80 g of adsorbent was added which is 52.07% right after the adsorption and filtration process. The lowest adsorption is 77.70% that's produced from 0.20% of HRS. During week 4, the initial concentration of Fe was 1.24 mg/L. The highest percentage adsorption is when 0.80 g of HRS was added which is 68.55%. The weather condition in week 4 was in a sunny day and windy season. The 58.06% was the lowest percentage removal of Fe when the amount of adsorbent 0.20 g was added. The result showed the concentration level of the metal each week were different based on the weathers condition. Based on the result analysis, the highest concentration of Ferum was during week 2 which is 1.46 mg/L while the lowest concentration is on week 1 which is 0.71 mg/L.

The reason why week 2 contained the highest concentrations of Ferum because the water samples were taken during the rainy season. When comes to rainy season, Iron content in the river will be higher. Heavy rainfall caused fertilizers and pesticides flow into the river. As we know, oil palm cultivation requires a lot of fertilizers and pesticides usage. The soil starts to become contaminated by the accumulation of heavy metal that produced from land application of fertilizers and pesticides. Based on the studied and observation, agriculture was the source of soil and water contamination. According to Umesh Bhauraoji Kakde from his studies on heavy metal contamination in Mithi River, Mumbai, Fe is a naturally derived metallic pollutant which owes its origin in H_2O mostly from sources derived from soil and rocks[7]. The large quantities of iron were leaked out when soil runoff, especially in acidic conditions. Based on the experiment, the accumulation of Fe in Kangkar Senangar's river was associated with degradation of excessive organic matter accumulated in the soil. The accumulation of Fe in the river can cause problem in the domestic use of water.

However, through the adsorption and filtration treatment, the concentration of Fe can be decreased based on the result obtained. This is because Hibiscus Rosa Sinensis leaves contains proteins, vitamin C, organic acids (essentially malic acid), flavonoids and anthocyanin. The ability of hibiscus extract as a natural starch and sucrose blocker is found to lower starch and sucrose absorption when absorb at reasonable doses by inhibiting amylase which in turn an influence the glycemic load favorably[8]. Hibiscus is a medicinal herb widely used against hypertension, pyrexia, and liver disease in indigenous medicines. According to the research and studies about adsorption of heavy metal, the higher the amount of adsorbent, the more the removal of heavy metal. Based on the result produced, the hypothesis was achieved. Overall, the highest adsorption of Fe by HRS leaves was 85.62% which when the 0.80g of adsorbent was added during week 2. In conclusion, the result showed that the average adsorption of Fe in each week achieved in a range of 70 to 80%. This proved that Hibiscus Rosa Sinensis leaves was an effective natural sorbent.

Laboratory Test
Turbidity

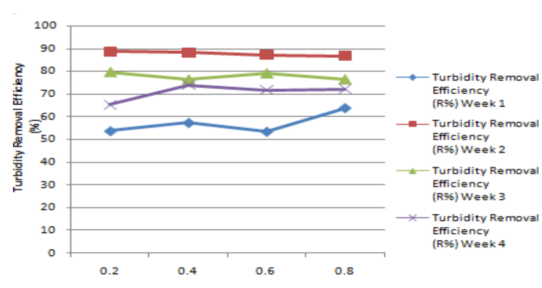

Figure 4.3. The graph turbidity removal efficiency for 4 week

Based on the result (Figure 4.3), the highest turbidity removal efficiency was on week 2 which is 88.61% while the lowest turbidity removal ion was in the week 1 which is 53.58% then followed by week 3 and week 4. During week 2, the initial turbidity was so high which in the range of 80 NTU. This is because the Kangkar Senangar's river was contaminated by the breaking down of the soil. The weather's condition during that time was heavy rain season. The heavy rainfall caused the soil became loose. Besides, there were several villager's houses around the river. Based on the investigation, there was a dumped of solid waste around the river. This could be another factor why the river contained high turbidity. When rainfall, the leachate of the waste entered the river produced high contamination. After adsorption and filtration, the turbidity was decreasing to 11.3 NTU from 80 NTU. This showed a great decline amount of turbidity. For week 1 and week 4, as the adsorbent dosages increased, the turbidity removals increased. This showed that the HRS leaf has adsorbed the particle and contaminant that caused high turbidity.

After adsorption process, the water sampling colour became green. That was because Hibiscus Rosa Sinensis leaves powder was green in colour and the shaken of conical flusks for 20 minutes made the water sample needs to be filtered. After filtration by using biosand filtration, the water sample became clearer and whiter. The bio sand filtration also help filtered the Hibiscus Rosa Sinensis leaves powder particle. The colour water sample after filtration by using the vacuum pump and bio sand filtration was different. When filtered by the vacuum pump, the water sample after adsorption still in green colour but not by using bio sand filtration. There were two mechanisms for slow-sand water filtration which mechanically filtering bacteria through the grains of sand and the adsorption of bacteria to a biofilm layer known as the schmutzedeck. Not only that, the coconut coir in the bio sand filtration also functioned as an adsorbent. The coconut coir adsorbs te particle in a water sample by binding the particle. Same to Hibiscus Rosa Sinensis leaves, there were functional groups such as hydroxyl and carboxyl that became main sites of metal binding.

pH

Table 4.2. Initial pH water sample before adsorption and filtration

pH	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1	6.39	6.51	6.09	6.15
Week 2	6.12	6.43	6.62	6.55
Week 3	6.81	5.94	6.28	6.71
Week 4	6.52	6.29	6.43	5.99

Table 4.3. Final pH water sample after adsorption and filtration

pH	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1	6.73	7.01	6.81	6.94
Week 2	6.50	6.58	6.92	6.70
Week 3	7.41	7.38	7.02	7.14
Week 4	6.76	6.50	6.61	6.49

Based on Table 4.2, the initial pH of Kangkar Senangar's river before adsorption and filtration was range 5~6.5. For week 1 and 2, the initial pH was below 6.5 which are acidic while for week 3 and 4, most pH within that weeks was above 6.5 which is a normal range of pH in surface water.

The pH has no direct effects on human health yet it has some indirect effects, by bringing changes in water quality parameters such as metal ion solubility and pathogen survival. However, high range of pH attributes bitter taste to drinking water [9,10]. After adsorption and filtration process, the pH was increased. It can be shown in Table 4.3.

All the for weeks shows a pH changed. The pH has increased turn to a normal range of pH in surface water. Overall water sample in week 1, 2, 3, and 4 contain a normal range of pH from 6.5 to 7.

Temperature

Table 4.4. Initial temperature of the water sample before adsorption and filtration

Temperature	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1		26.8		
Week 2	26.8	26.8	26.2	26.9
Week 3	26.1	25.6	26.8	26.6
Week 4	25.7	27.4	25.6	25.8
	27.3		27.2	27.2

Table 4.5. Final temperature of the water sample after adsorption and filtration

Temperature	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1			24.2	
Week 2	25.2	25.6	25.4	24.9
Week 3	25.2	25.1	24.7	
Week 4	24.3	24.2	26.3	25.4
	26.3	26.5		25.0
				26.8

Based on the result above (Tabke 4.4 and 4.5), the initial temperature for all the weeks are in the range of 25~27 ºC while the temperature after adsorption and filtration are 24~26 ºC. This showed that temperature of water decreases 2 ºC only. There are not many changes in temperature parameter.

Dissolved Oxygen

Table 4.6. The concentration of dissolved oxygen in water samples before adsorption and filtration

Dissolved Oxygen	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1	8.36	8.46		
Week 2	4.48	4.44	8.91	8.46
Week 3	7.14	7.18	4.47	
Week 4	6.43	6.71	7.78	4.47
			6.81	7.79
				6.80

Table 4.7. The concentration of dissolved oxygen in water samples after adsorption and filtration

Dissolved Oxygen	Adsorbent Dosages(g)			
	0.2	0.4	0.6	0.8
Week 1		8.60		
Week 2	8.20	7.94	8.81	8.90
Week 3	8.12	8.35	7.45	
Week 4	8.32	7.57	8.41	7.83
	7.93		7.37	8.40
				7.81

Based on Table 4.6, the dissolved oxygen (DO) level in water sample before adsorption and filtration was in range 6.43 until 8.91 mg/L except the DO level in week 2. This is because the temperature of samples before the process is higher, then the DO increased due to activity of microorganism in the water samples. The dissolved oxygen (DO) level in water sample after adsorption and filtration showed in Table 4.7, the values were in the range of 7.37 until 8.90 mg/L. This showed that the dissolved oxygen was increased after adsorption and filtration. According to the temperature result, the temperature of the water sample after adsorption and filtration much cooler than before the process. This showed that the oxygen dissolves more easily in cooler water than warm water. The amount of moving water also influenced the entrance of oxygen in the water sample.

The water was shaken for 20 minutes in the adsorption process, which can conclude that as the water sample moving continuosly, the volume of dissolved oxygen will be added into the water.

CONCLUSIONS

In conclusion, the results obtained from this study revealed the Hibiscus Rosa Sinensis (HRS) leaves was an effective low-cost adsorbent for the removal of Iron (Fe) in the aqueous solution. The adsorbent had good adsorption capacity for Fe as the higher the dosages of HRS leaves, the higher the percentage of adsorption. The higher adsorption of Iron in this study was 85.62% which almost 100%. This can be proved by the functional groups that present in the proximate composition of the Hibiscus Rosa Sinensis leaves that were investigated by Fourier transform infrared (FTIR).

However, bio sand filtration also helps in the treatment process. As the water became greeny after adsorption because of HRS leaves colour, the bio sand filtration produced the clearer water and filter the water sample. The pH of the water has increased and turn into a normal range of pH in surface water which is 6.5-7.41. The highest turbidity removal in this study was 88.61% during week 2 which showed a great high drop of turbidity level. Not only that, the value of dissolved oxygen has increased after adsorption and filtration. The value of dissolved oxygen was above 5.0 mg/L, which is safe for the aquatic life to live.

ACKNOWLEDGEMENT

The author would like to thank UTHM for funding this study using Grant Tier 1 H201, Universiti Tun Hussein Onn Malaysia.

REFERENCES

1. G. Vilardi, 2018, L. Di Palma, and N. Verdone, "Heavy metals adsorption by banana peels micro-powder: Equilibrium modeling by non-linear models," *Chinese J. Chem. Eng.*, vol. 26, no. 3, pp. 455–464.
2. A. Tripathi and M. Rawat Ranjan, 2015, "Heavy Metal Removal from Wastewater Using Low Cost Adsorbents," *J. Bioremediation Biodegrad.*, vol. 6, no. 6.
3. S. A. Baig, Q. Mahmood, B. Nawab, M. N. Shafqat, and A. Pervez, 2011, "Improvement of drinking water quality by using plant biomass through household biosand filter - A decentralized approach," *Ecol. Eng.*, vol. 37, no. 11, pp. 1842–1848.
4. A. Demirbas, 2008, "Heavy metal adsorption onto agro-based waste materials: A review," vol. 157, pp. 220–229.
5. C. K. Jain, D. S. Malik, and A. K. Yadav, 2016, "Applicability of plant based biosorbents in the removal of heavy metals: a review," *Environ. Process.*, vol. 3, no. 2, pp. 495–523.
6. J. Shunmuga Vellan, P. Lakshmanan, and D. Basker Reddy, 2015, "Formulation development and characterization of Hibiscus Rosa-Sinesis dry leaves mucilage as smart polymer for pharmaceutical use," *Int. J. Appl. Res. Nat. Prod.*, vol. 8, no. May, pp. 28–36.
7. J. Hussain, I. Husain, M. Arif, and N. Gupta, 2017, "Studies on heavy metal contamination in Godavari river basin," *Appl. Water Sci.*, vol. 7, no. 8, pp. 4539–4548.
8. D. Philip, 2010, "Green synthesis of gold and silver nanoparticles using Hibiscus rosa sinensis," *Phys. E Low-Dimensional Syst. Nanostructures*, vol. 42, no. 5, pp. 1417–1424.
9. S. Muhammad, M. T. Shah, and S. Khan, 2011, "Health risk assessment of heavy metals and their source apportionment in drinking water of Kohistan region, northern Pakistan," *Microchem. J.*, vol. 98, no. 2, pp. 334–343.
10. Ghani, A.B.A., Mahat, N.I., Hussain, A., Mokhtar, S.S.M. (2019). Water Sustainability In Campus: A Framework In Optimizing Social Cost. International Journal of Recent Technology and Engineering, 8 (2 Special Issue 2), pp. 183-186.