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Removal of Oil and Grease from Oily Kitchen Wastewater by Using Raw Kapok as a Potential Adsorbent

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Abstract

Oil and grease are one of the elements that are poisonous and easily pollute the environment, especially water and soil. Adsorption techniques use natural adsorbents that do not damage or pollute the environment. The raw kapok was chosen as an adsorbent because it is a technology to overcome the problem of oil produced globally. The experiment was conducted with two types of dosage which are 5g and 15g of raw kapok to absorb the oil and the results stated that raw kapok can absorb the cooking oil that is still not used more than the cooking oil that has been used. Due to the density of the oils, it affects the ability of raw kapok to absorb and hold oil. In addition, this absorbed oil restores several water parameters such as dissolved oxygen (DO), pH, temperature and turbidity.

1. Introduction

A significant amount of waste is generated by industry and oil that is discarded daily. The waste that contains oil or the oil itself is mainly produced from any production activities such as oil and gas, the food industry, transportation and more [1]. Oil can be released in very low or very high concentrations, typically between 1 and 50%, and produces oily wastewater, which typically contains the oil [2]. There are various technologies and treatments to overcome the problem of oil or oil spills on the water's surface such as membrane plasma treatment [3]. One of the treatments is absorption because of the use of natural adsorbent sawdust, feathers, human hair, and other natural materials because of their characteristics that are light, easy to float and waterproof [4]. As one of the grey wastewater that is from dispersed homes and small dining establishments, it has drawn attention from all over the world due to the existence of organic pollutants like oil, grease, and fatty acids that will have an impact on the ecosystem by choking sewer pipes and eutrophicating water bodies [5]. Cooking oil, which is released when it comes into contact with temperatures above 200 ºC in the kitchen and forms hazardous and toxic substances, is a common component of oily kitchen wastewater [6]

Oil-contaminated wastewater is majorly in O/W emulsions which has an impact on physical characteristics like temperature, pH, and the presence of oil droplets while the chemical parameters like dissolved oxygen (DO), biochemical oxygen demand (BOD), and others will be impacted [7]. Kapok fiber showed promise as a replacement material for use in oil pollution treatment by exhibiting good water repellent, high oil adsorption capacity, and well-reusable qualities [8]. In order to research the sorption condition of kapok fiber on industrial wastewater, the raw kapok fibres were in contact with a variety of wastewater types, including emulsified wastewater, immiscible oil-and-liquid wastewater, and non-oily wastewater [9].

Through this study, the adsorbents have a significant capacity for absorbing oil off the water's surface, which lowers treatment costs and lessens detrimental effects on ecosystems [9]. Not only that, but the discoveries made in this study will help to solve the issue of biochemical oxygen demand (BOD), dissolved oxygen (DO), p All of the tests utilized in this study are fundamental ones that examine how oil interacts with

water. Furthermore, the project's goals have been met by demonstrating the oil adsorbents' capacity to hold oil after it has been absorbed. Therefore, to support this topic, researchers, teachers, and students can use this study as their reference. Accordingly, references from this study can also raise community awareness of the necessity of protecting water sources from the presence of oil.

2. Methods

There are several methods used to obtain results of oil absorption, the capability of raw kapok to retain oil after absorption and water quality parameters such as dissolved oxygen (DO), pH, temperature and turbidity.

2.1 Preparation of Oil adsorbents and Oily Kitchen Wastewater

Prepare an amount of raw kapok by purchasing from Shoppe because it is a crucial part of conducting the study so that the objectives of this study can be achieved. The original raw kapok from the tree itself is purchased to provide two types of adsorbent oil with different masses. The two oil adsorbents from raw kapok are 5g and 15g. Since raw kapok is utilized for both types of oil adsorbents with two different masses, there is no need for these oil adsorbents to undergo any procedure or process, like soaking in hydrochloric acid or drying in the oven. A small net is used to keep the raw kapok in shape after absorbing the oil. For oily kitchen wastewater that used the grab sampling method, 500ml of kitchen wastewater from Kolej Kediaman Pagoh Cafe and mixed with 80ml oil.

2.2 Oil Absorption Test

Cooking oil will be weighed in for 80ml is used for both used and unused types. Next, four beakers will be filled with 500ml of kitchen wastewater and 80ml of oil; two with samples of 5g raw kapok and four with samples of 15g raw kapok. The two beakers for 5g and 15 raw kapok represent unused and used oil. After each minute which is 5, 10, 15 and 20 minutes, the oil adsorbents will be removed and weighed the mass. The values that will be obtained are entered into equation 1 to obtain the efficiency of oil and grease (O&G) in %.

$$O\&G\ (\%) = \frac{W_A - W_B}{W_A}\ X\ 100\% \tag{1}$$

Where:
W_A= Weight of total oil
W_B= Weight of oil absorbed

2.3 Capability of Oil adsorbents to Retain the Oil

Oil adsorbents that are removed after the absorption time is set, are hung and there is a bowl below to catch the oil that drips out of the oil adsorbents for 20 minutes. After 20 minutes have passed, the oil dripping into the bowl is weighed to obtain the W_c value. Below is the equation 2.

$$Retained\ Oil\ (mg) = \ W_A - W_C \tag{2}$$

Where:
W_A= Weight of oil adsorbent with the absorbed oil (mg)

2.4 Dissolved Oxygen (DO) and pH

A Hach Multi-Meter has been used to determine the DO and pH of every sample of oily kitchen wastewater since this meter has two detectors. So, the readings can be taken at the same time. The instrument is thoroughly rinsed with distilled water and then wiped with a new tissue before measuring the pH by submerging it. To improve accuracy and consistency, pH readings were taken three times for each sample.

2.5 Temperature

To obtain a temperature reading for each sample in the eight beakers, a Hach Multi-meter was used to obtain a reading. Each sample was read three times to increase consistency and accuracy.

2.6 Turbidity

In order to obtain turbidity readings for samples from eight beakers, a Hach Tungsten Lamp Turbimeter was used. The wastewater sample is poured into the sample cell and the lid is tightly closed. The sample was placed into a sample holder in the instrument. Readings were taken three times to ensure an average turbidity reading.

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3. Result and Discussion

Table 1 shows the type of oil used in this study with quantity, mass and density for reference discussion in this paper.

Table 1 *The type of oil with their quantity, mass and density*

Type of oil	Quantity (ml)		Mass		Density of Oil (kg/l)
	ml	l	g	kg	
Unused cooking oil	80	0.08	103	0.103	1.288
Used cooking oil	80	0.08	113	0.113	1.413

3.1 Effects on Oil Absorption on Both Oils for Both Oil Adsorbents

Fig. 1 shows the percentage of oil absorption vs time on unused cooking oil for 5g and 15g absorbents for unused cooking oil. Based on Fig. 1, the oil absorbent in both cooking oils, the longer the time is explained, the oil absorbed also increases. For unused cooking oil, the increase in absorbed oil is different for 5g and 15g. The highest oil absorption is oil absorbent 15g with a value of 94.9% in 20 minutes while for oil absorbent 5g at the same time, it is 85.8%. This shows that the longer the time, the more oil is absorbed by raw kapok. This result shows that raw kapok is an oil adsorbent because it capability to absorb the oil in high percentages because the capacity of raw kapok is 13-14% higher than the capability of the 100% nettle non-woven [10]. Meanwhile, Fig. 2 shows the graph of percentage oil absorption vs time on used cooking oil with 5g and 15g raw kapok as the potential adsorbent.

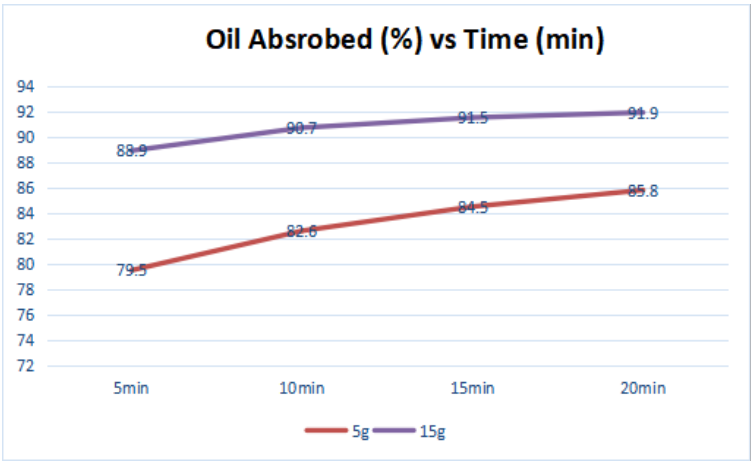

Fig. 1 *Percentage of oil absorption vs time on unused cooking oil for 5g and 15g absorbents*

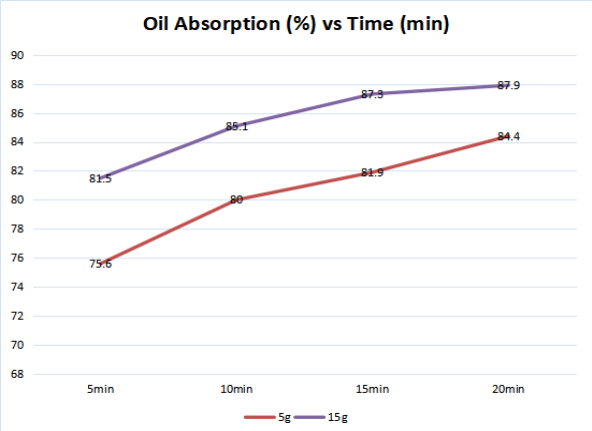

Fig. 2 *Percentage of oil absorption vs time on used cooking oil for 5g and 15g absorbents*

The highest oil absorption is oil absorbent 15g with a value of 87.9% in 20 minutes while for oil absorbent 5g at the same time it is 84.4% minutes. However, the 15g of raw kapok absorbed used cooking oil in this result just 87.9% which less than the 15g of raw kapok absorbed unused cooking oil with 94.9%. The 7% difference shows the efficiency of raw kapok to absorb used cooking oil is slightly lower than the efficiency of raw kapok to absorb unused cooking oil. When referring to Table 2, the density for used cooking oil is 1.413kg/l which is higher than the density of still unused oil with 1.288 kg/l. The conclusion from the results is that the higher the density, the lower the ability of raw kapok as an oil adsorbent [8].

Table 2 *Parameter of kitchen wastewater*

Sample with Unused Cooking Oil							
DO		pH		Temperature		Turbidity	
Initial	After	Initial	After	Initial	After	Initial	After
9.18	8.56	8.05	8.23	24.0	24.9	357	127
8.88	8.84	8.03	8.21	24.0	24.9	307	101
8.88	8.53	7.98	8.19	24.3	24.9	367	125
8.98	8.64	8.02	8.21	16.81	24.9	343.67	117.67
Sample with Used Cooking Oil							
DO		pH		Temperature		Turbidity	
Initial	After	Initial	After	Initial	After	Initial	After
8.54	8.59	8.12	8.18	25.2	25.5	309	189
8.48	8.44	8.12	8.17	25.9	25.9	361	187
8.48	8.34	8.17	8.18	25.9	25.5	358	172
8.50	8.46	8.14	8.17	25.67	25.63	342.67	182.67

Based on Table 2, the initial and after DO of the unused cooking oil is slightly higher than the used cooking oil. This is because the temperature of the sample with unused is also lower than the sample with used cooking oil. The value of dissolved oxygen is parallel to the temperature [2]. While for pH, the sample with used cooking oil is high because it has gone through the burning process that causes rapid oxidation in oils at high pH [3]. For turbidity, both readings for unused and used cooking oil are higher than the readings after using raw kapok as an oil adsorbent.

3.2 Result of Oil Retain After Absorption Test

Table 3 shows the mass of oil that has been removed from 5g and 15g kapok by hanging the raw kapok with the bowl underneath. The oil that has been dripped out from raw kapok is the result in this table. From this table, for the unused cooking oil, the highest oil that was removed out from the 15g raw kapok was 13g while the 5g raw kapok was removed 6g oil after 20 minutes. Meanwhile, for used cooking oil, the 15g adsorbent has 13g oil removal and the 5g raw kapok has 12g oil removal after 20 minutes hanging. This result proves that the higher density is parallel to the mass, so the used cooking oil with 1.413kg/l has dripped out of the raw kapok while the lower density has less dripped out. The ability of raw kapok as the oil adsorbent to hold oil after being absorbed depends on the density of the oil [11].

Table 3 *Oil removal after absorption test*

Oil Removal (g)					
		Unused Cooking Oil		Used Cooking Oil	
	Oil Adsorbent	5	15	5	15
Time(min)	5	1	5	2	4
	10	3	8	6	8
	15	4	10	9	12
	20	6	13	12	13

4. Conclusion

In conclusion, raw kapok is still capable of being an oil adsorbent as one of the technologies to get rid of excess oil spilt in drains, rivers, and the sea. Through experiments and the results obtained, the ability of raw kapok as an oil adsorbent depends on a factor such as density which is parallel to mass. The higher the density, the higher the mass. Low-density oil can be accommodated more by raw kapok after 20 minutes instead of high-density oil.

The research conducted is also not complex enough to prove raw kapok as one of the natural oil adsorbents. In addition, raw kapok guarantees the well-being of the environment because it is eco-friendly. For future studies, there should be a new adsorbent oil innovation where this new absorbent is formed by several natural absorbents such as raw kapok mixed with human hair.

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Conflict of Interest

There are no conflicts of interest to declare.

Author Contribution

Nur Hanis Arina Termizi contributed to the research and manuscript preparation. Hazren A. Hamid provided supervision, guidance, and oversight throughout the study.

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