ISSN PRINT 2319-1775 Online 2320-7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

The Preliminary Study of Utilizing Potato Peel Waste as a Sustainable Material in Adsorption of Oils

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Abstract
Oil pollution management is one of the serious emerging environmental issue all over the world. Due to its biodegradation and buoyancy adsorption is considered as one of the cost effective technology for pollutant management. The use of eco-friendly and low cost adsorbent has been studied as an ideal alternative substitution to the current expensive methods for removal of oils. Potato peel, the most appropriate domestic and food processing industrial waste, is currently obtaining sufficient attraction, owning to its wide availability and potentiality in environmental conservation. The untreated potato peels were cut into small pieces and dried under sunlight for 48 hours. Then, it was further dried in an oven for 24 hours and ground into powder. The adsorbent was used to adsorb different types of oils such as diesel oil, used engine oil, and waste cooking oil with different amounts of adsorbent which is 0.1 g, 0.2 g, 0.3 g, 0.4g, and 0.5 g for adsorbent dosage experiment. This preliminary study aimed to use potato peel for oil removal and proposed that the potato peel has a good potential as a low cost bio adsorbent for oil removal and to manage environmental pollution.

Key words

Adsorption, Potato peel, oil pollutants,

Introduction
The uses of oil as an energy resource is very popular, and it is already being commercialized around the world. However, if oil is explored, transported, stored, and used too widely, chances of oil spillage are high hence, posing severe problem and damage to the environment. The oil spilled is not only messy but is also hazardous and will eventually threaten our lives [1] .Mostly, oil is released into the water bodies and sometimes these oil spills can occur in the land. Spilled oil can also contaminate ground and drinking water supplies. It can cause waterborne and diarrheal diseases to human. Therefore, it is important to remove oil spillage to maintain the environment and ecosystem. One useful solution for the removal of oils from environment is the treatment of effluent that comes from industry by using an efficient method [2] various methods such as gravity separation, dissolved air flotation, chemical coagulation, filtration, membrane process, and biological process are introduced for removing oil. All these technologies are very expensive [3] Adsorption technique is a simple, low cost, and eco-friendly physical remediation method. Different adsorbents, including synthetic, natural inorganic, and natural organic sorbents, have been applied in removing various contaminants from environmental media [4]. Moss, straw, wool, sawdust, and peel are the natural sorbents were evaluated for oil spill [5]. Hence, a simple experiment of adsorbent has been explored using waste biomaterials such as potato peel for oil removal purpose. Unwanted potato peel could be used to clean up oil spills, while also reducing food waste.Potatoes are a vital crop

ISSN PRINT 2319-1775 Online 2320-7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

worldwide, potentially contributing to food security greatly. Potatoes have been recognized by the Food and Agriculture Organization (FAO) as an exceptional crop due to their high nutritional value and ability to produce a substantial amount of dry matter per unit area and time [6]. The FAO declared 2008 as the "International Year of Potato" to recognize the crucial role that potatoes can play in addressing global food security and poverty alleviation. Potatoes are grown on an area of 18.13 million hectares, accounting for 376.12 million tons of global production [7]. Potato farming can play a significant role in meeting the food needs of the growing population in developing countries and can enhance dietary quality with their rich vitamins, minerals, and superior protein content. Instead of replacing staple foods, potatoes can complement a well-rounded diet that includes various vegetables and whole grains [8]. Potatoes are usually peeled during processing and production losses in a form of potato peel waste (PPW) can vary from 15 to 40%, depending on the peeling method. Each year huge quantities of PPW as a by-product remain after industrial potato processing [9]. Contains a large quantity of starch, non-starch polysaccharides, lignin, polyphenols, protein and small amount of lipids. This makes it a cheap and valuable base material for extraction of valuable products [10] Oil removal using potato peel can be achieved using extraction, chemical coagulation and ultra-filtration, however, it incurs high cost. The adsorption method in removing oil spills have been considered a better way of controlling pollution and the natural adsorbents are preferred to be used. Adsorption is the process by which a solid adsorbent can attract a component from aqueous phase to its surface. Natural adsorbents are not only biodegradable when disposed, but more efficient than chemical adsorbent as they showed a greater adsorption capacity, eco-friendliness and cost effectiveness.

In the proposed study, adsorbent dosage which is the use of adsorption method between potato peel adsorbent and the different types of oil. At the end of the experiment, the percentage of oil removal and adsorption capacity of oil in the treated and untreated adsorbent is recorded. Therefore, the objective of this study is to produce a low-cost adsorbent from potato peels waste for oil removal.

Experimental work

Untreated adsorbent: In this the potato peel was collected then rinsed with tap water and dried under the sunlight for 48 hours to remove some of the moisture. Then, it was put in the oven for one hour at 70 °C to remove the residual moisture in the peels. After that, it was ground by using into powder. Lastly, it was sieved using a machine to get the particle size of 250 µm before it is used for the testing of the removal of oil. [11]

Treated adsorbent: In this with an additional steps after drying under sunlight, it was impregnated with 0.5 M NaOH solution for 48 hours. The peels were then rinsed with distilled water and dried again under the sunlight for 3 days. The dried peels were soaked in a beaker containing 1000 ml of 0.5 M HNO3 for about 30 minutes. This was done to neutralise the peels surface which could stop the NaOH reaction [12]. Afterwards, the peels were rinsed with distilled water and extra pure water. Then, the peels were dried under the sunlight for 2 days, prior to drying inside the oven for 4 hours at 60°C to eliminate all moisture. It is then ground into powder and sieved to achieve 250 µm of particles in size. Therefore, for the effect of adsorbent dosage the samples are labelled as UT1–UT5 for untreated adsorbent and TT1– TT5

ISSN PRINT 2319-1775 Online 2320-7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

for treated adsorbent, according to its process conditions as shown in Table 1. The specified amount of untreated adsorbent was packed in a tea bag and placed inside a beaker. Following procedures by [13], a volume of 20 ml of diesel oil was poured into the beaker and left at room temperature for 25 minutes to allow the adsorption of oil

Sample	Mass of adsorbent(g)	Types of oil	Samples	Mass of adsorbent(g)	Types of oil
	Untreated adsorbent			***Treated adsorbent***	
UT1	0.1	Diesel	TT1	0.1	Diesel
UT2	0.2	Diesel	TT2	0.2	Diesel
UT3	0.3	Diesel	TT3	0.3	Diesel
UT4	0.4	Diesel	TT4	0.4	Diesel
UT5	0.5	Diesel	TT5	0.5	Diesel
UT6	0.1	Used engine oil	TT6	0.1	Used engine oil
UT7	0.2	Used engine oil	TT7	0.2	Used engine oil
UT8	0.3	Used engine oil	TT8	0.3	Used engine oil
UT9	0.4	Used engine oil	TT9	0.4	Used engine oil
UT10	0.5	Used engine oil	TT10	0.5	Used engine oil
UT11	0.1	Waste vegetable oil	TT11	0.1	Waste vegetable oil
UT12	0.2	Waste vegetable oil	TT12	0.2	Waste vegetable oil
UT13	0.3	Waste vegetable oil	TT13	0.3	Waste vegetable oil
UT14	0.4	Waste vegetable oil	TT14	0.4	Waste vegetable oil
UT15	0.5	Waste vegetable oil	TT15	0.5	Waste vegetable oil

TABLE 1: Sample notations according to process parameters for untreated potato peel adsorbent

The final mass of the adsorbent in tea bag was recorded. Next, the percentage of oil removal and the adsorption capacity were calculated using Eq. (1) [11].

$$\% \text{ of oil removal} = \left(\frac{Wo - Wi}{Wo}\right) \times 100\ \%$$

Where: Wi is the initial mass of adsorbent (g) and Wo is the final mass of adsorbent (g)

ISSN PRINT 2319-1775 Online 2320-7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

These procedures were repeated for all the oils in this study, the adsorption of diesel, used engine oil and waste vegetable oil were tested

Results and discussion

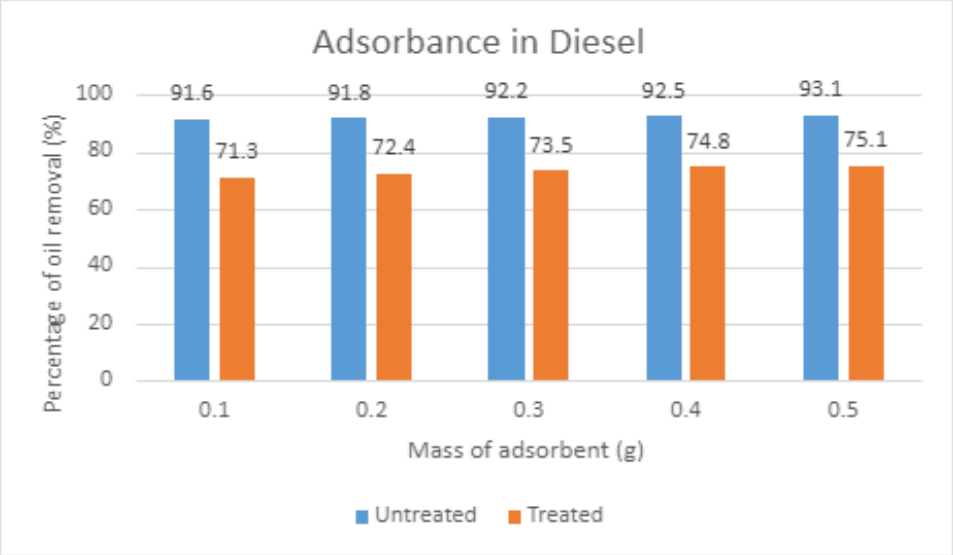

Fig.1: Effect of adsorbent dosage on Diesel removal using untreated and treated potato peel

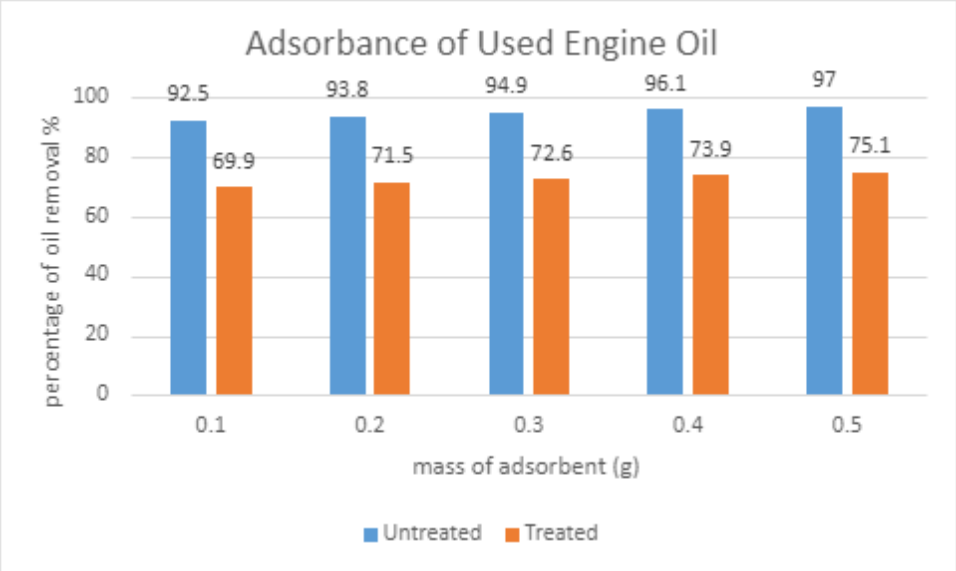

Fig.2: Effect of adsorbent dosage on used engine oil removal using untreated and treated potato peel

ISSN PRINT 2319-1775 Online 2320-7876

 UGC CARE Listed (Group -I) Journal Volume 11, Iss 11, November 2022

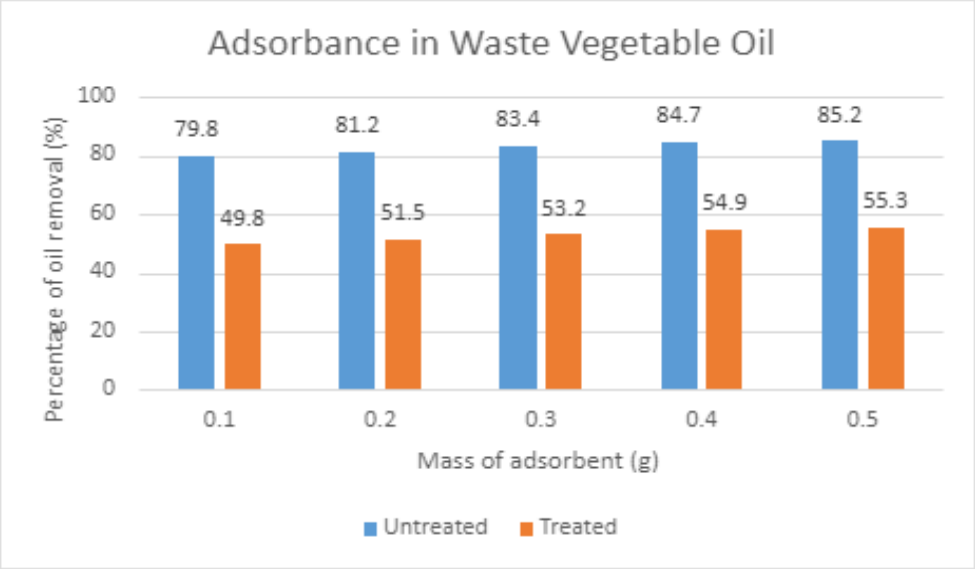

Fig.3: Effect of adsorbent dosage on Waste vegetable oil removal using untreated and treated potato peel

Fig. 1–3 show the effect of dosage on removal of diesel, used engine oil and waste vegetable oil, respectively. Using untreated and treated potato peels adsorbent. Overall, it is observed that increasing mass adsorbent dosage resulted in higher percentage of oil removal. The adsorption capacity of all adsorbents increased by increasing the adsorbent dosage. Previous studies have shown that percentage of oil removal is directly proportional to adsorbent dosage [12] the greater the dosage of the adsorbent, the more effective the adsorption of oil because more surface area is available for the adsorption to occur. Meanwhile, the percentage of oil removal using untreated adsorbent is higher than the treated adsorbent. From Fig. 1, the percentage of diesel oil removal for samples UT1 and TT1 are 91.6% and 71.3%, respectively. Samples UT5 also shows higher percentage of oil removal 93.1% than the treated adsorbent of sample 75.1%. From Fig. 2, it was observed that sample UT6was capable of removing 92.5 % used engine oil compared to the treated adsorbent of sample TT6 is 69.90%. Meanwhile, the percentage of oil removal for sample UT10 and sample TT10 increased to 97.1% and 75.10%, respectively. This depicts that the higher the mass, the higher the percentage of oil removal. Moreover, from Fig.3, sample UT11 of 0.1g untreated adsorbent was able to remove 79.8% of oil, while sample TT11 removed 49.81% of oil. Similar to the trend of diesel and lubricant oil removal, the percentage of oil removal for sample UT15 and sample TT15 is 85.20% and 55.30%, respectively. This is because untreated adsorbent has larger and more surface area than the treated, thus adsorbs more oil and resulted in higher percentage of oil removal [14]. When the adsorbent is treated with acid and alkali, the particles in the adsorbent collide with each other, causing less surface area of the adsorbent and results to a less adsorption of the oil [15].

ISSN PRINT 2319-1775 Online 2320-7876

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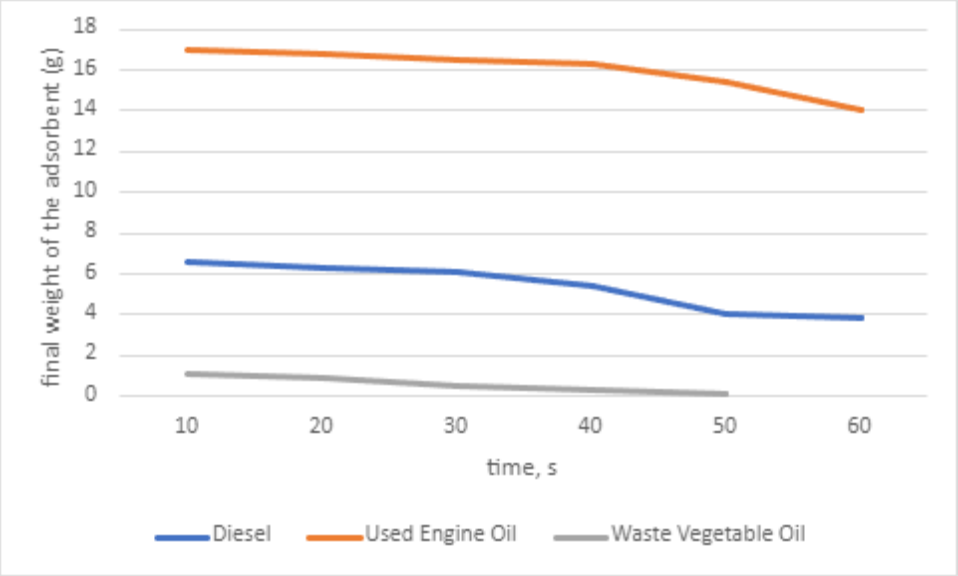
Retention Time

The retention time demonstrates how well the potato peels will hold the waste fuel oil (Fig 4). It is an important parameter as it is related to the time of removal of sorbents from the contaminated area to assigned location. The sorbent with good retention time is needed all the times. The retention time was observed from about 2 g oil / g sorbent. Highest retention time was observed in used engine oil. [16, 17]



Reusability:

When testing the potato peels powder for its reusability, the waste fuel oil was squeezed out of the sorbent by applying pressure to the saturated test sorbent in the process of squeezing the sample causes irreversible deformation of the sample and caused ultimately decreases its capacity for further adsorb of waste fuel oil. The process of squeezing the sample causes irreversible deformation of the sample and ultimately decreases its capacity to further waste fuel oil adsorption. The oil sorption capacity of potato peels powder had decreased by 65% after three time of usability. The low usability times were due to the nature of the materials that could not adsorb oil efficiently. [18]

Conclusion:

The main objective of this study is to produce a low cost adsorbent from waste biomass material for cleaning oil spills. This study clearly proves that the process of removing oil using potato peel waste as an adsorbing medium is efficient at laboratory scale. Potato peel is available in huge quantities at food industries, fast food restaurants and it can be used as sorbent material. It can be concluded that the percentage of oil removal is directly proportional to the adsorbent dosage. Potato peels powder was used as sorbent material for adsorbing waste lubricating oil. The evaluation of potato peels powder showed that it can adsorb oil up to more than 2 g of oil /g of sorbent and it can adsorb oil in a very fast process and can keep the oil for long time. This is a very important property which called oil retention.

ISSN PRINT 2319-1775 Online 2320-7876

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