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Performance Evaluation of Chemically Modified Rice Husk as an Adsorbent for the Treatment of Oil Seed Industrial Effluent

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ABSTRACT: The generation of oilseed wastewater is a matter of worry due to the presence of impurities that could have effects on ecosystems and human health. This study explores the potential use of rice husk chemically modified with 1M NaOH as an adsorbent to treat wastewater from Sunseed Nigeria Limited in Zaria, Nigeria. The adsorbent was characterized employing Fourier transform infrared spectroscopy (FTIR), which revealed the presence of carboxylic acid, alkanes, alkynes, and amide. Correspondingly, batch adsorption tests were conducted for a fixed period of 1 hour by using dosages of 2, 4, 8, 16, and 20 g. The findings indicated that the turbidity, BOD, and COD had the highest percentage of removal at dosages of 2 g, 20 g, and 2 g, respectively, with removal percentages of 81.48 %, 81.3 %, and 85 %. Also, lead and cadmium had removal percentages of 17.5% and 87.6%, respectively, at a dosage of 20 g. Furthermore, the Langmuir isotherm offered a greater fit for turbidity and total solids, with R^2 values of 0.5355 and 0.8870, respectively, with the resultant absorption capacities of 0.0074 mg/g and 0.0249 mg/g. Similarly, the Freundlich isotherm described the BOD and COD well, with R^2 of 0.6097 and 0.9678, respectively, and relative adsorption capacities of 1.3104 mg/g and $4.808*10^6$ mg/g. Therefore, it can be concluded that the rice husk adsorbent has demonstrated effectiveness in removing certain physicochemical pollutants from oilseed industrial wastewater.

Key words: Freundlich, langmuir, oil seed, pollutants, percentage removal

1. INTRODUCTION

Water contamination takes place when effluent or other waste materials are dumped into the water, which contains substances that can potentially alter the physical, chemical, or biological characteristics of the water, thus affecting the existence of different living species, reducing the beneficial uses of water, and increasing the cost of treatment for subsequent reuse [1, 2, 3]. The wastewater obtained from industrial activities is generally more contaminated compared to domestic or even commercial wastewaters and if it is not well managed, human health could be impaired [4, 5, 6]. However, there are instances where certain industries release their effluent directly into natural river streams without proper authorization. This behaviour on the part of industries can lead to severe contamination of the entire river water and environment, making its purification a challenging task [7, 8].

In some cases, industries discharge their wastewaters into municipal sewers, thereby making the treatment of such municipal sewage a complex and costly endeavour. Also, legal regulations generally prohibit industries from discharging untreated effluents [9]. The oil seed industry holds a significant position in the global economy as it provides important raw materials for various sectors, including food, pharmaceuticals, and cosmetics [10]. However, the production processes in this industry produce significant volumes of effluent that contain substantial concentrations of organic and persistent substances.

These waste materials present a considerable environmental challenge due to their potential to contaminate water bodies and soil, resulting in detrimental impacts on ecosystems [11, 12]. Moreover, effective treatment of effluent from the oil seed industry is essential to minimize its environmental consequences and comply with regulatory standards [13]. To this end, various treatment methods, like physical, chemical, and biological processes, have been applied to eradicate contaminants from wastewater [3, 14].

However, to surmount the limitations linked with traditional treatment techniques, it is important to investigate different and sustainable approaches for the management of oil seed industrial effluent. One such approach involves the utilization of agricultural waste, specifically rice husk, as an absorbent material for the extraction of pollutants from wastewater [15, 16, 17].

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Moreover, rice husk has been discovered to possess adsorption characteristics due to its high silica content and porous structure [18, 19]. However, exhaustive investigations are required to assess the effectiveness of rice husk as an adsorbent material for the treatment of oil seed industrial effluents [20]. The outcomes of such studies will provide researchers with a better understanding of the effectiveness of rice husk in treating oil seed industrial wastewater as a sustainable and cost- effective adsorbent material. The findings will also provide valuable information on the adsorption capacity and removal efficiency of different physicochemical parameters, such as turbidity, biological oxygen demand (BOD), chemical oxygen demand (COD), total solids (TS), and pH. The acquirement of this knowledge can be of great assistance in the advancement of effective and ecologically conscious treatment systems for the oil seed industry, thereby diminishing its impact on the environment and promoting sustainable practices.

Consequently, the primary objective of this investigation is to assess the effectiveness of chemically modified rice husk, treated with a 1M solution of sodium hydroxide (NaOH), as an adsorbent for the treatment of industrial effluent from the oil seed sector obtained from Sunseed Nigeria Limited. Furthermore, the study also examined the applicability of both the Langmuir and Freundlich isotherm models, with the objective of identifying the model that most accurately depicts the adsorption process.

2. MATERIALS AND METHODS

2.1 Materials

The laboratory equipment consists of 300ml conical flasks, 250ml beakers, petri dishes, a hot-air oven, a small local mortar and pestle, a 10ml pipette, a 50ml burette, a 250ml measuring cylinder, 25ml test tubes, a BOD bottle, filter paper, a funnel, a bent glass rod, wash bottles, a lovibond apparatus, a weighing balance, incubator, desiccator, water bath, spatula, forceps, magnetic stirrer, atomic adsorption spectrophotometer (AA650FS), pH meter, standard sieve (300µm), manganese (II) sulphate (MnSO4), alkaline-iodide-azide, teteraoxosulshate (VI) acid (H_2SO4), potassium dichromate solution ($K_2Cr_2O_7$), and sodium thiosulphate ($N_2S_2O_3.5H_2O$).

2.2 Methods

2.2.1 Study area

The wastewater sample was gotten from Sunseeds Nigerian Limited, which is situated at Dakace in Zaria, Kaduna State, Nigeria. This facility is located in the North-western region of Nigeria, precisely at the latitude and longitude coordinates of 11°4'52" and 7°45'27", correspondingly. It regularly encounters a minimum temperature of 14°C and a maximum temperature of 39°C. The goggle map layout of the region is illustrated in Figure 1.

2.2.2 Preparation of rice husk adsorbent

The raw rice husk obtained from local rice millers in Zaria, Kaduna State, Nigeria underwent a process of purification using distilled water to eliminate any impurities. Afterwards, the rice husk was subjected to an oven drying process at a temperature of 100 °C for a duration of 24 hours. The resultant dried rice husks were then finely ground into a powder form, employing a grinder, and subsequently passed through a standard sieve with a defined aperture size of 300 µm. The sieved rice husk was then mixed with a solution of 1M NaOH and subjected to continuous agitation for a period of 1 hour, with a ratio of 1 g of rice husk to 2 mls of NaOH. Following this, the rice absorbent material was once again subjected to oven drying, this time for a duration of 3 hours at a temperature of 100 °C, after which it was stored for future utilization.

Fig. 1. Google map showing Sunseed Oil Nigeria

2.2.3 Batch adsorption experiment

Batch absorption experiments were carried out by introducing a specified mass (2, 4, 8, 16 and 20 g) of the rice husk adsorbent into a 250 ml flask containing 100 ml of the effluent from the oil seeds industry. It was then subjected to agitation for a duration of 1 hour utilizing a magnetic stirrer operating at a consistent speed of 200rpm. Subsequently, it was allowed to settle for 1 hour, following which the liquid above the sediment was collected and subjected to analysis for turbidity, biological oxygen demand, chemical oxygen demand, and total solids in accordance with the guidelines for the examination of water and wastewater. In a similar manner, experiments pertaining to the adsorption of lead and cadmium were conducted using a dosage of 20 g, while maintaining other conditions as previously mentioned.

The adsorption capacity at equilibrium (qe) and removal efficiency (E) are determined utilizing equations (1) and (2), respectively; whereas equations (3) and (4) represent the Langmuir and Freundlich isotherms, correspondingly (Idris et al., 2011; Adamu and Adie, 2020).

$$q_e = \left(\frac{C_0 - C_e}{m}\right)V \quad (1)$$

$$E = \frac{(C_o - C_e)100}{C_0} \quad (2)$$

$$\frac{C_e}{q_e} = \frac{1}{bq_m} + \frac{C_e}{q_m} \quad (3)$$

$$\log q_e = \log k_f + 1/n \log C_e \quad (4)$$

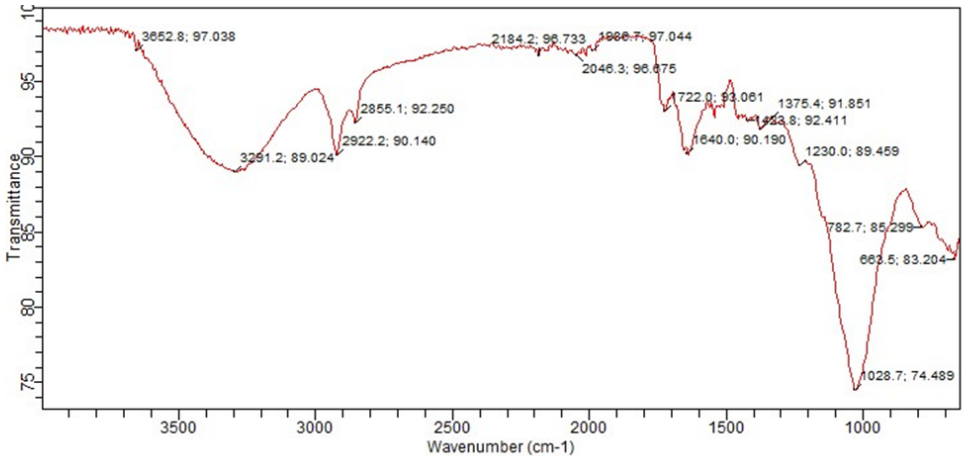

Fig. 2. FTIR of unmodified rice husk

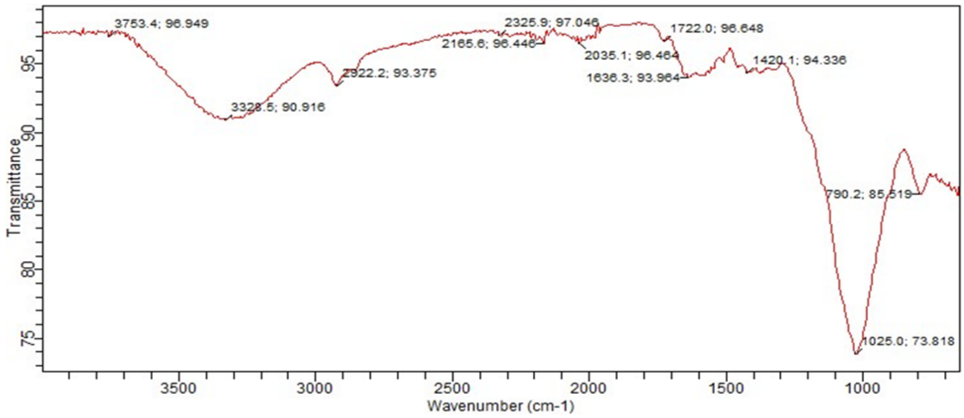

Fig. 3. FTIR of modified rice husk adsorbent

Where; C_0 is the initial concentration of the pollutant, C_e is the final concentration of the pollutant, V is the volume, m is the dosage of the rice husk adsorbent, q_m is the Langmuir adsorption capacity, k_f is the Freundlich adsorption capacity, b and n are the Langmuir and Freundlich constant, respectively.

3. RESULT AND DISCUSSION

Figures 2 and 3 indicate the Fourier Transform Infrared spectroscopy (FTIR) of the unmodified and modified rice husk.

The FTIR result of unmodified rice husk as shown in figure 2 suggests the existence of various functional groups, including carboxylic acid, alkanes, alkyls, alkynes, acyl chloride, anhydrides, amide, aromatic, esters, alkenes, and ethers. These functional groups suggest that the untreated rice husk possesses the capability to adsorb certain physical and chemical contaminants from industrial wastewater through the eradication of acidic contaminant (carboxylic acid or hydroxyl), organic contaminants (alkanes, alkyls, alkynes, aromatics, alkenes), and nitrogen-containing contaminants (amide) [21]. The existence of acyl chloride, anhydrides, and ethers indicates its potential for chemical reactions and the elimination of specific contaminants. They could indirectly influence wastewater treatment processes through chemical reactivity, solubility properties and potential interactions with contaminants or treatment chemicals. In another study carried out by [22], the FTIR results of magnetised biochar carbonized at 400 °C revealed that it contains alkenes, alkynes, amines, hydroxyl and carbon (iv) oxide. Similarly, [3] also reported the presence of hydroxyl functional group in rice husk adsorbent utilized in the work.

Figure 3 illustrates the FTIR outcome of modified rice husk, revealing the functional groups of the rice husk that has undergone chemical treatment with 1M NaOH. The figure demonstrates that the modification with 1M NaOH led to the removal of certain peaks and the introduction of others. The modification also contributes to the enhancement of the performance of the rice husk adsorbent in the adsorption of physical and chemical contaminants in the oilseed industrial effluent by improving pore spaces.

The existence of carboxylic acid in the treated rice husk suggests that it has the potential to function as an adsorbent for organic pollutants in wastewater. This is due to the effective removal of contaminants, including heavy metals, by the functional groups present. Additionally, the identification of amines suggests that the modified rice husk may possess that the NaOH modified rice husk possesses the ability to adsorb organic compounds.

Another study conducted by [23] revealed that the rice hull activated carbon, which had undergone chemical modification using H_3PO_4, exhibited functional groups such as C=O, C=C, O-H, and C-H. This suggests that the findings from the FTIR analysis concurred with those obtained in the present investigation.

In the context of industrial wastewaters, these compounds are frequently harmful to the environment. Against all odds, aldehydes are likely to react with various pollutants. Furthermore, the existence of carbon dioxide in the processed rice husk might potentially go through chemical reactions during the treatment procedure. This is evidenced by the formation of carbonates or other carbon-containing compounds, which may influence the treatment of wastewater containing carbon-based pollutants.

Table 1 Concentrations of the parameters oil seed industrial effluent before treatment

Parameters Analysed	Initial concentrations (C_1)	FEPA limit for discharge into surface water
pH	6.58	6-9
Turbidity (NTU)	40.5	-
BOD (mg/l)	80	50
COD (mg/l)	2000	250
TS (mg/l)	2800	30
Lead (mg/l)	0.324	<1
Cadmium (mg/l)	0.250	<1

(FEPA = Federal Environmental Protection Agency, Nigeria)

Table 1 presents the concentrations of the effluent from the oil seeds as well as the Nigerian standard provided by Federal Environmental Protection Agency (FEPA) for the discharge of wastewater into surface water. The information in the table indicates that the oil seeds wastewater is mildly acidic, with a pH of 6.58. This acidic nature could potentially have negative implications for both aquatic life and the environment. Furthermore, the turbidity level of 40.5 NTU implies the existence of suspended particles or solids in the discharged waste. This could have detrimental effects on the ecosystems of the receiving streams. Moreover, the biological oxygen demand (BOD) level of 80 mg/l hints that the wastewater might have been contaminated with organic pollutants.

In the same vein, the chemical oxygen demand (COD) result of 2000 mg/l signifies a significant presence of refractory pollutants in the effluent. Such high levels of refractory pollutants can be harmful to aquatic life as they deplete the dissolved oxygen levels. In addition, the COD to BOD ratio of 25 suggests that the effluent contains a higher proportion of refractory substances compared to organic matter. This implies that the effluent possessed biodegradability. From the table, it could be observed that the BOD, COD and TS concentrations of the effluent were higher than the recommended value by FEPA for discharge into the river.

Furthermore, the total solids (TS) concentration of 2800 mg/l indicates a high concentration of suspended and dissolved solids. The high levels of BOD, TS and COD deplete the dissolved oxygen, could lead to disruption of ecosystems and negatively impact the visibility of aquatic organisms and ultimately lead to their death [24]. In addition, the death of aquatic organisms can potentially contribute to an escalation in the odour of the wastewater.

Also, the levels of lead and cadmium in the discharge are 0.324 mg/l and 0.25 mg/l, respectively. The presence of these heavy metals suggests that the oil seed effluent contains harmful elements. It is of utmost importance to acknowledge that lead and cadmium are toxic and can cause severe environmental and health effects. Hence, the contents of lead and cadmium suggest that the industrial effluent requires appropriate treatment and management to decrease its adverse effects.

Figure 4 illustrates the variations in pH with different dosages of rice husk adsorbent, ranging from 2 to 20 g. Following treatment with 2 g of the adsorbent, the pH rose from 6.58 to 7.11, suggesting that the rice husk adsorbent played a part in neutralizing the acidity of the effluent, because of its modification with 1M NaOH. This trend continued with increasing dosage of the adsorbent. This infers that the treatment method is effective in adjusting the pH towards a more neutral level, which is advantageous for water quality. It is worth mentioning that maintaining a balanced pH is crucial in the treatment of water and wastewater, as excessively high or low pH levels can present challenges in the treatment processes.

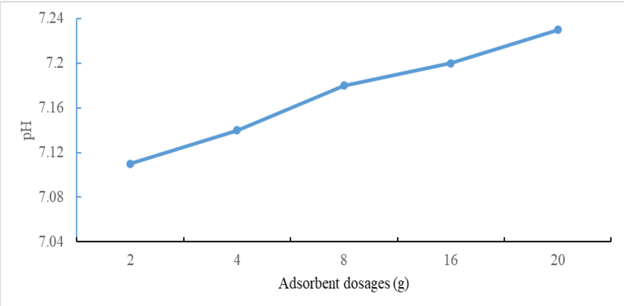

Fig. 4. Variations in pH with increase in the rice husk adsorbent dosages

Table 2 illustrates the application of the rice husk adsorbent, in a quantity of 2, 4, 8, 16 and 20 g for the treatment of the oil seed effluent. It is evident from the table that the turbidity of the effluent decreased from an original amount of (C_1) 40.5NTU to a final quantity of (C_2) 7.5NTU, indicating a significant removal efficiency (E) of 81% after the addition of 2 g of the adsorbent. This outcome suggests that the rice husk adsorbent effectively reduced the suspended particles or solids from the effluent, leading to a reduction in turbidity. Consequently, it can be inferred that the treatment resulted in treated effluent that is less turbid. It's worth mentioning that high turbidity levels in water could block light penetration and negatively affect the visibility of aquatic organisms.

Table 2 Treatment of oil seed wastewater with 2, 4, 8, 16 and 20 g of rice-husk absorbent dosages

Parameters	C_2	E (%)	C_2	E (%)	C_2	E (%)	C_2	E (%)	C_2	E (%)
Dosages (g)	2.0		4.0		8.0		16.0		20.0	
Turb. (NTU)	7.5	81	14.5	64	20.6	49	55.2	36	87.2	115*
BOD (mg/l)	60	25	40	50	60	25	20	75	15	81
COD (mg/l)	300	85	300	85	600	70	900	55	1500	25
TS (mg/l)	3280	17*	3820	36*	5590	99*	7800	178*	9100	225*

(* implies higher than initial concentration, Turb. = Turbidity, C_2 = concentration after treatment, E = the removal efficiency)

The BOD concentration experienced a decrease from 80mg/l to 60mg/l, indicating a reduction of organic substances in the oilseed effluent by 25%. Similarly, the COD concentration decreased from 2000mg/l to 300mg/l following the treatment, indicating an efficiency of 85% in the removal process. This implies that the utilization of rice husk adsorbent proves effective in diminishing the organic and refractory pollutants present in the effluent. The decrease in BOD and COD concentrations is very likely to have a significant impact on maintaining the quality of water and preventing any potential harm to both human and aquatic ecosystems.

Conversely, the TS concentration increased from 2000mg/l to 3280mg/l after the addition of 2 g of the rice husk adsorbent. This suggests that the adsorbent may have introduced additional solutes into the effluent during the treatment process. Nonetheless, this does not undermine the efficacy of the rice husk adsorbent in treating the effluent, as demonstrated by the decrease in turbidity, BOD, COD, as well as the adjustment of pH values.

In a separate investigation conducted by [2], the usage of 2 g of rice husk activated carbon resulted in a decrease of BOD in tannery wastewater from 190 to 96 mg/l, indicating a reduction of 49%; while the COD was reduced by 46.7%, from 460 to 245 mg/l. This further supports the effectiveness of modified rice husk as an adsorbent in the lessening the pollutants from wastewater.

The removal of turbidity, BOD, and COD was also through the utilization of 4 g of the rice husk adsorbent. It is worth mentioning that the turbidity was reduced from 40.5NTU to 14.5NTU, indicating the effectiveness in reducing the particles that cause turbidity in the effluent. This is crucial as high turbidity can hinder the penetration of sunlight, thereby affecting photosynthesis.

On the other hand, the BOD reduced from 80 mg/l to 40 mg/l at 4 g dosage, indicated a drop in organic pollutants in the effluent by 50%. This outcome is beneficial since high BOD levels can deplete the dissolved oxygen in bodies of water, resulting in the demise of aquatic organisms. Subsequently, the demise of aquatic organisms in streams is accompanied by taste and odour. The removal efficiencies specified in Table 2 demonstrate the success of the NaOH modified rice husk in enhancing the quality of the effluent.

Similarly, the results of treating the effluent with 8g of rice husk adsorbent as shown in table 2 reveal the turbidity decline from 40.5NTU to 20.6NTU, indicating a decrease of 49%. This signifies the effectiveness of the adsorbent in removing the suspended particles. It is equally crucial in maintaining a clear industrial discharge that supports a healthy aquatic environment.

In a study carried out by [5] on the treatment of petroleum products contaminated water using activated carbon generated from *Hura crepitans* linn seeds, it was discovered that the turbidity, COD and BOD were reduced to 1.1 NTU, 148 mg/l and 15.5 mg/l, respectively from the corresponding initial values of 2.5 NTU, 373 mg/l and 52.6 mg/l, indicating the efficacy of the adsorbent in the treatment.

In a similar manner, as shown in table 2, the BOD declined by 25% at dosage of 8 g as it went down from 80mg/l to 60mg/l. It also denotes a lessening in organic contaminant concentration in the effluent. Also the COD dwindled from 2000mg/l to 600mg/l, corresponds to a 70% decrease. This indicates a possible reduction in refractory pollutants, which are resistant to biodegradation and relatively difficult to remove. Additionally, high COD levels could diminish dissolved oxygen in water bodies, thereby leading to death of aquatic organisms, which ultimately causes odour [16]. A study by [25] reported the efficiency of water melon seed in removing turbidity and BOD from raw water. The report revealed that 95.78% and 86.79% of BOD and turbidity were removed at 0.3 g/l and 0.2 g/l, respectively of water melon seed dosages. This further justified the significance of agricultural by product in treating wastewaters.

The Turbidity increased from 40.5 NTU to 55.2 NTU as shown in table 2, reveals a rise of 36%. On the other hand, the BOD reduced from 80mg/l to 20mg/l as observed in the table, signifying a reduction in organic content of the industrial wastewater by 75%. Moreover, the COD declined from 2000mg/l to 90mg/l, designating a notable reduction of refractory pollutants by 55%. Conversely, the rise in TS levels from 2000mg/l to 7800mg/l probably indicate the addition of solute substances from the rice husk adsorbent. But, this does not underscore the significance of rice adsorbent in treating the effluent.

The efficacy of a 20g quantity of rice husk adsorbent in the treatment of oil seed effluent is also indicated in table 2. The turbidity experienced an increase from 40.5NTU to 87.2NTU, while the BOD witnessed a decrease from 80 to 15 mg/l, indicating a substantial reduction of 83%. Furthermore, the COD exhibited a decrease from 2000 to 1500 mg/l, revealing a decline of 25%.

In a study conducted by [15], it was observed that 96.69% and 37.50% of turbidity and BOD, respectively, were effectively removed from grey water through the use of 1.0 g of lemon peel as an adsorbent. Similarly, [26] reported the favourable of removal of 87%, 79%, 54%, 95% and 100% removal of nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, phosphorus and E. Coli, respectively, using the activated carbon prepared from rice husk and coconut husk which were chemically modified using $ZnCl_2$.

Table 3 portrays the decrease in the lead and cadmium contents within the oil seed effluent upon the addition of 20 g of rice husk adsorbent. The table displays the initial concentrations of lead and cadmium, which are 0.324 and 0.250 mg/l, respectively. These concentrations were decreased by 17.5 and 87.60 % when a dosage of 20 g was employed.

Table 3 Removal of lead and cadmium from oilseed effluent using 20 g of the rice husk adsorbent

Heavy metals analysed	Initial concentrations	Final concentrations	Percentage Removal (%)
Lead (mg/l)	0.324	0.267	17.50
Cadmium (mg/l)	0.250	0.031	87.60

The outcome suggests that the rice husk adsorbent effectively lessened the presence of lead and cadmium, thereby indicating its appropriateness in the treatment of the industrial effluent derived from oil seeds. [2] Has documented a drop in lead concentration from 0.036 to 0.021 mg/l by employing 4 g of activated carbon derived from rice husk, implying a noteworthy increase of 94.0 %. It is of significance to acknowledge that the existence of cadmium in water can lead to renal ailments, respiratory abnormalities, cardiac complications, hepatic impairments, and cancer [14].

Figure 5 displays the Langmuir isotherm plot for COD, which was used to determine the model parameters.

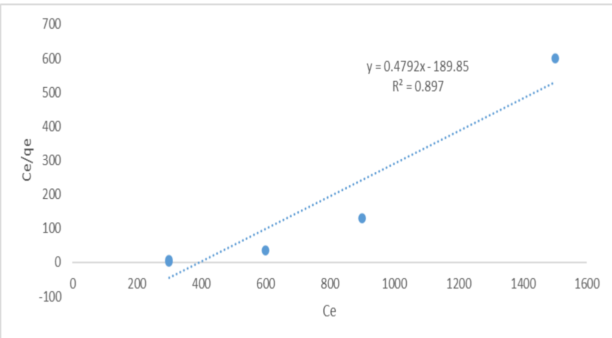

Fig. 5. Langmuir plot for COD

Table 4 presents the equation of the Langmuir isotherm model, coefficient of determination (R^2), adsorption capacity (qm), and the Langmuir constant (b) for COD. The adequacy of the Langmuir isotherm in describing the adsorption of the effluent parameters is ascertained by the magnitude of the R^2. The higher the R^2, the greater the appropriateness of the isotherm in describing the adsorption of the pollutants. The table indicates that the Langmuir adsorption capacity of 2.087 mg/g was recorded with the relative R^2 of 0.897 for the COD.

Table 4 Langmuir adsorption model for COD.

Parameters	COD
Model (m; c)*	0.4792; -189.85
R^2	0.897
qm (mg/g)	2.087
-b	0.0025

(*) linear model y = mx + c

Figure 6 indicates the Freundlich isotherm plots; while Table 5 illustrates the Freundlich isotherm model parameters for COD.

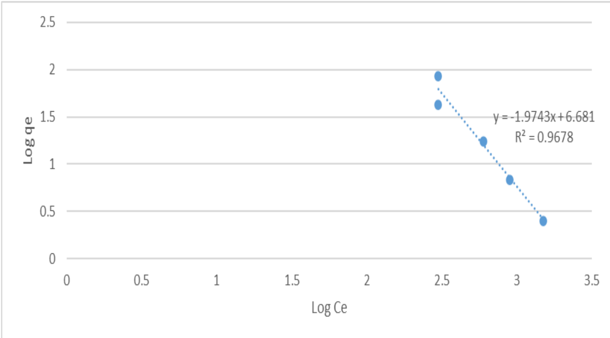

Fig. 6. Freundlich plot for COD

The table 5 indicates that the Freundlich adsorption of $4.808*10^6$ mg/g was achieved with the comparative R^2 of 0.9678. The COD adsorption is better represented by the Freundlich isotherm model, as suggested by the higher values of R^2 of 0.9678 obtained for the model compared to the lower values of R^2 of 0.897 for COD achieved for the Langmuir isotherm model.

Table 5 Freundlich adsorption model

Parameters	COD
Model (m; c)*	-1.9743; 6.681
R^2	0.9678
k_f (mg/g)	$4.808*10^6$
-n	0.506

(*) linear model y = mx + c

Additionally, [16] demonstrated that the adsorption of COD from wastewater using rice husk chemically modified with $ZnCl_2$ followed the Langmuir isotherm model, with a maximum adsorption capacity of 45.9 mg/g. In another study carried out by [27], the adsorptions of Fe (III) and Mn (II) from wastewater onto activated carbon produced thermally from rice husk was found to fit into Langmuir model. In the study, the adsorption capacities of

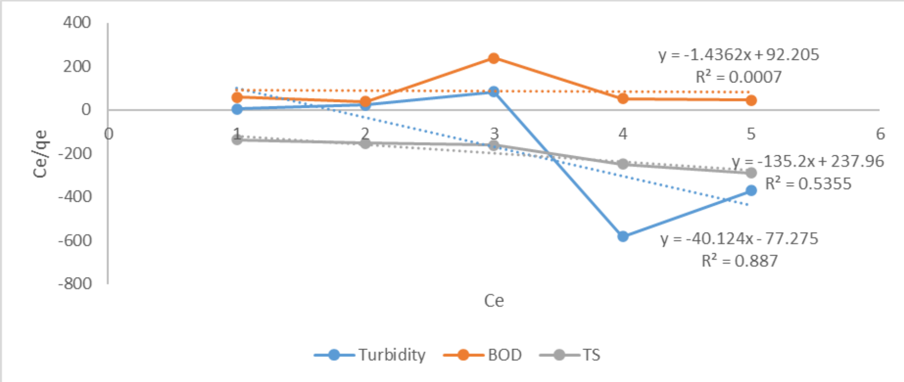

Fig. 7. Langmuir isotherm plots for turbidity, BOD and TS

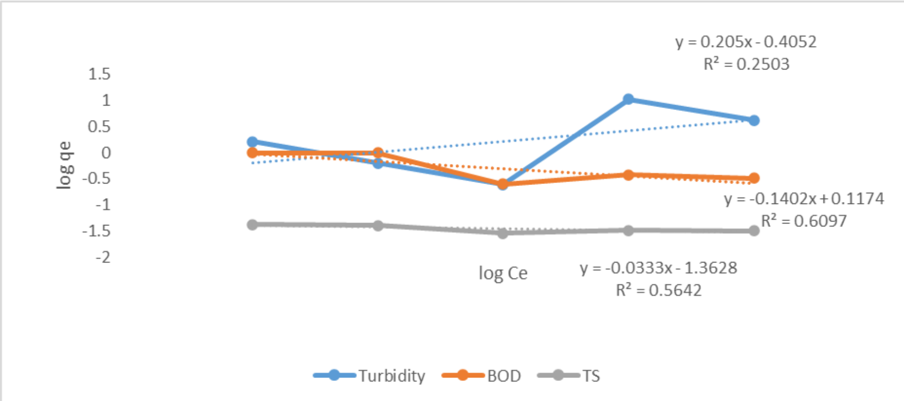

Fig. 8. Freundlich isotherm plots for turbidity, BOD and TS

Fe (III) and Mn (II) were recorded to be 0.0061 mg/g and 0.0046 mg/g, respectively with the relative R^2 of 0.94 and 0.91. On the other hand, [28] reported that adsorption of cadmium onto sugarcane bagasse activated carbon fitted Freundlich isotherm model with adsorption capacity of 2.0137 mg/g and relative R^2 of 0.9471.

The Langmuir and Freundlich isotherm plots for turbidity, BOD and TS are shown in figures 7 and 8, respectively.

Table 6 Freundlich isotherm plots for turbidity, BOD and TS

Parameters	Turbidity	BOD	Total Solids
Model (m; c)*	-135.20; 237.96	-1.44; 92.20	-40.12; -77.28
R^2	0.5355	0.0070	0.8870
qm (mg/g)	0.0074	0.6960	0.0249
B	0.5680	0.0156	0.5192

(*) linear model y = mx + c

Furthermore, the Langmuir and Freundlich isotherm parameters for turbidity, BOD and TS are shown in Table 6 and 7, respectively. The tables indicate that the turbidity and TS were better defined by the Langmuir isotherm model with the corresponding R^2 values of 0.5355 and 0.8870, respectively; with corresponding adsorption capacities of 0.0074 mg/g and 0.0249 mg/g. On the other hand, the BOD fitted more to the Freundlich isotherm model than the Langmuir with R^2 value of 0.6097 as shown in table 7. The adsorption capacity for BOD recorded is 1.3104 mg/g.

Table 7 Freundlich adsorption model

Parameters	Turbidity	BOD	Total Solids
Model (m; c)*	0.205; -0.4025	-0.140; 0.117	-0,033; 1.363
R^2	0.2503	0.6097	0.5642
k_f (mg/g)	0.3934	1.3104	0.0434
N	4.878	7.133	30.03

(*) linear model y = mx + c

4. CONCLUSION

The wastewater from the oil seed industrial effluent exhibited certain characteristics, including pH, Turbidity, BOD, COD, and TS, which were measured at values of 6.58, 40.5 NTU, 80 mg/l, 2000 mg/l, and 2800 mg/l, respectively. The utilization of the rice husk absorbent proved to be effective in enhancing the quality of the oil seed industrial effluent. This was achieved by reducing the levels of turbidity, BOD, and COD by 81.46%, 25%, and 85%, respectively, with the addition of 2 g of the rice husk absorbent. Also, the pH has elevated from 6.85 to 7.11, pointing to a decline in acidity.

In addition, at a dosage of 20 g, the concentrations of lead and cadmium were found to decrease from 0.324 mg/l to 0.267 mg/l and from 0.25 mg/l to 0.031 mg/l, respectively, signifying a decline of 17.5% for lead and 87.6% for cadmium. The turbidity and TS were better defined by the Langmuir isotherm model with the corresponding R^2 values of 0.5355 and 0.8870, respectively; with equivalent adsorption capacities of 0.0074 mg/g and 0.0249 mg/g. Similarly, the Freundlich isotherm model appropriately described the relationship between BOD and COD, with corresponding R^2 values of 0.6097 and 0.9678, respectively, than the Langmuir isotherm. In addition, the adsorption capacity for BOD and COD was found to be 1.3104 mg/g and $4.808*10^6$ mg/g mg/g, respectively. In conclusion, the chemically modified rice husk using 1M NaOH proves to be a cost-effective adsorbent for the treatment of Sunseed oil industrial wastewater.

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