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# Characterizaton Of Rice Husk For The Treatment Of Tannery Waste Water

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***Abstract:*** ***Tannery effluent is a serious threat to the environment. It needs low cost adsorbents for the removal of various types of organic and inorganic pollutants. Activated carbon is one of the most common adsorbent used for adsorption and absorption processes for removing various types of organic and inorganic materials. Thus, it has been revealed that, rice husk which is a low cost agricultural product can be used as adsorbent to absorb water pollutants from wastewater. The prepared adsorbent was characterized based on the moisture content, bulk density, surface area, fourier transform infrared (FTIR) spectroscopy, surface morphology and thermos-gravimetric analysis (TGA).The results obtained from the characterization of the adsorbent indicated that the prepared adsorbent have good adsorptive properties with a surface area 865-452 ($m^2/g$) for rice husk. The bulk density; 0.235g/$cm^3$, moisture content; 0.05%, and surface morphology properties showed them to be good adsorbents. Optimum operating conditions are concluded to be a contact time of 60 minutes at an adsorbent dosage of 5 g at ambient room temperature.***

***Keywords:*** ***Rice husk, Torsion, Surface area, Optimum dosage, Adsorption.***

## I. INTRODUCTION

Industrialization activities for national development contribute to global environmental deterioration as these activities cause depletion and degradation of natural resources and biodiversity. In addition, these industrial activities indirectly overload water body with thousands of water pollutant and subsequently polluting the environment. Adsorption is a process which involves a solid phase (sorbent material) and a liquid phase (solvent, normally water) containing a dissolved species to be sorbed (sorbate, metal ions). Due to higher affinity of the sorbent for sorbate species, the latter is attracted and bound there by different mechanisms. The process continues till equilibrium is established between the amount of solid-bound sorbate species and its portion remaining in the solutions. The degree of sorbent affinity for the sorbate determines its distribution between the solid and the liquid phases [Ahalya, N.,et et al, 2003].

The discharge of industrial wastewaters with high concentrations of chemical contaminants results in chemical hazards on the receiving environmental component [Abdelkareem, M., 2013]. These hazards include injury and damage to environmental resources among which are aesthetic nuisance, health disorder, damage to aquatic life and degradation of environmental resources [Girods, P.et al, 2009 and Lazo-Cannata, J.C., et al 2011].

Rice husk is an agricultural waste produced as by-products of the rice milling industry. More than 545 million tonnes is generated worldwide, developing countries account for 96% of this. Common practice of disposing rice husk is by burning, thereby producing $CO_2$ and releasing toxics contaminants and solid particles to the environment. The use of this source of biomass will solve both a disposal problem and also lead to production of cheaper material for adsorption in water pollution control system [Williams and Nugranad, 2000]. The components of rice husk are carbon and silica, it has the potential to be used as an adsorbent [Khalid, Ahmad and Toheed, 2000. and, Nakbanpote, 2000]. When rice husk is

burnt, about 20 wt% of the husk remains as ash. The rice husk ash has more than 95 wt% of silica with high porosity and large surface area, because it retains the skeleton of cellular structure.

ANATOMY AND PROPERTIES OF RICE HUSK

Rice husk has 8 – 10 mm long, 2.0 – 2.5 mm wide, and 0.1 – 0.15 mm thick (Daifullah et al., 2002). Furthermore, chemical properties of rice husk are more explained by Rahman et al. (1997) and it is tabulated in Table 1. Moreover, Table 2 shows the reported values of rice husk physical properties.

| COMPOSITION PERCENT (%) | COMPOSITION PERCENT (%) |
|---|---|
| Cellulose | 32.24 |
| Hemicellulose | 21.34 |
| Lignin | 21.44 |
| Extractives | 1.82 |
| Water | 8.11 |
| Mineral ash | 15.05 |

*Table 1: Chemical Properties of Rice Husk (Rahman et al., 1997)*

| CHARACTERISTICS VALUES | CHARACTERISTICS VALUES |
|---|---|
| Bulk density (g/ml) | 0.73 |
| Solid density (g/ml) | 1.5 |
| Moisture content (%) | 6.62 |
| Ash Content (%) | 45.97 |
| Particle size (mesh) | 200 – 16 |
| Surface area (m2 /g) | 272.5 |
| Surface acidity (meq/gm) | 0.1 |
| Surface basicity (meq/gm) | 0.45 |

*Table 2: Physical Properties of Rice Husk (Malik, 2003)*

Rice husk is insoluble in water, have good chemical stability and structural strength due to high silica content (Lee et al, 1994). Hence researchers employ it for treating heavy metal from ground water and surface water.

## II. MATERIALS AND METHODOLOGY

*MATERIALS:* HACH spectrophotometer DR 2010, pH meter (Jenway model 3150), TDS conductivity meter, Number 42 Whatman filter paper, $H_2SO_4$, $BaCI_2$, iodine thiosulphate, 4_aminoantipyrene,potassium ferricyanide, chloroform and anhydrous $Na_2SO_4$.

SPECIFIC SURFACE AREA

Saers method was used for the determination of the surface area, the volume V required to raise the pH from 4.0 to 9.0 was noted and the surface area was computed from the Equation 1:

$s$ [m2/g] = $32v - 2$ ……1

Where: s = surface area
v= volume required to raise the pH
m= mass of the adsorbent (g)
g= acceleration due to gravity

MOISTURE CONTENT

The moisture content of the adsorbents was determined by the difference in the mass constitutes of the amount of moisture content of the adsorbent, Equation 2.

$\%\ moisture\ content$ =w2-w3/w2-w1 ……2

Where: W1 = Weight of crucible
W2 = Initial weight of crucible with sample
W3 = Final weight of crucible with sample

BULK DENSITY

The bulk density of each of the adsorbents was determined using Archimedes principle using Equation 3:

$Bulk\ density$ = w2-w1/v ……3

Where:
W1 = Weight of empty measuring cylinder
W2 = Weight of cylinder filled with sample
V = Volume of cylinder

FOURIER TRANSFORM INFRARED (FTIR) SPECTROSCOPY

The Fourier transform analysis of the samples was performed using Thermo scientific Nicolet attenuated total reflection (ATR) instrument (6700). The samples were scanned at resolution of 4cm (32 scans) from wavelength 500 to 4000 wavelength. The software shows the spectra of sample containing peaks of different functional groups which will be used for the identification of functionalities of sample surface.

THERMO-GRAVIMETRIC ANALYSIS (TGA)

The thermal behavior and decomposition pattern via thermos-gravimetric analysis was recorded on a TGA/DSC (SDT-Q600) analyzer by heating dry powder of the adsorbents at 10°c.

ADSORBATE PREPARATION AND CHARACTERIZATION

Physicochemical parameters including COD, BOD, DO, nitrates, phosphates, pH and metal ion concentration of the effluent sample were analyzed following standard method of water and wastewater treatment. Membrane filters of 0.45µm that were dried at 103°C for one hour, weighed and placed in a desiccator were used to determine the total suspended solids (TDS). A sterile container was used to collect the sample and mixed thoroughly by inverting the bottles several times to obtain a homogeneous mixture. Sample of 100 mL was poured into the membrane filter assembly holding the previously weighed membrane filter and attached to a suction pump and then filtered. The filter paper was then dried at 103°C and reweighed. Total suspended solids concentration was afterwards obtained by deducting the initial weight of the filter paper from its final weight. Physicochemical parameters such as nitrates, phosphates were all determined using Standard Methods for the Examination of Water and Wastewater (APHA, 2012). The pH and temperature of the samples were analyzed using the multi-parameter photometer and

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thermometer respectively. The concentration of COD of respective samples was calculated using Equation 4:

COD =1000(a-b) N/volume of sample used (ml)mg/L …4

Where, a and b are the respective volumes of $FeSO4$ $(NH4)_2SO_4.6H_2O$ used for blank and sample (ml), VIS the volume of sample used (ml) and N normality of Fe $(NH_4)$ $2SO_4$.

## III. RESULTS AND DISCUSSION

### CHARACTERIZATION OF THE ADSORBENT

The rice husk was characterized for the following (a) Bulk density, (b) moisture content, (c) Surface area, (d) pH (e) electrical conductivity (g) fourier transform infrared (FTIR) spectroscopy, (h)surface morphology using scanning electron microscopy (SEM), electron dispersive spectrum (EDS), and thermos-gravimetric analysis (TGA).

The results of the characterizations are presented in the table below

| S/N | PARAMETER | VALUES |
|---|---|---|
| 1 | Bulk Density | 0.235g/cm$^3$ |
| 2 | Moisture Content | 0.05% |
| 3 | Surface Area | 865-452 (m$^2$/g) |
| 4 | pH | 6-7 |
| 5 | Electrical Conductivity | 0.46ds/m |

*Table 3: Physicochemical Characterisation of Rice husk*

*BULK DENSITY:* the value of bulk density in rice husk is 0.235g/cm3 as presented in table1 above. Powdered carbon of most adsorbent used in the decolourization has a bulk density ranging from 0.25-0.75g/cm3, this result is compared to that of G.D. Akpen et al (2016) where the value of bulk density of *Albizia Salman* pod activated carbon is 0.135g/cm3. Bulk density of a good adsorbent should not be less than 0.25g/cm3 (Saad A.M et al 2022).

*MOISTURE CONTENT:* This is a measure of the amount of water present in an adsorbent. Though moisture content has no effect in the adsorption capacity of the adsorbent, high amount is usually discourage because it usually increases the amount of adsorbent during adsorption process. However the value of moisture content of rice husk in the research is 0.05%

pH: the pH value of the rice husk, shows that the adsorbent can perform well at neutral condition.

*SURFACE AREA:* The value of the surface area of rice husk is 865-452m2/g, this high value reflects that the rice husk is a good adsorbent, because the large surface area, the high the rate of adsorption.

### SURFACE MORPHOLOGY

SEM images was obtained to study the surface behavior of rice husk, this image shows a more irregular texture and porous nature of the adsorbent surfaces. This rough irregular surface and increased number of pores indicates higher or increased surface area, (Swarna, 2012). The 4 SEM images labelled a, b, c, and d in Plate I for rice husk with different magnifications of 666x, 477x, 477x and 815x respectively.

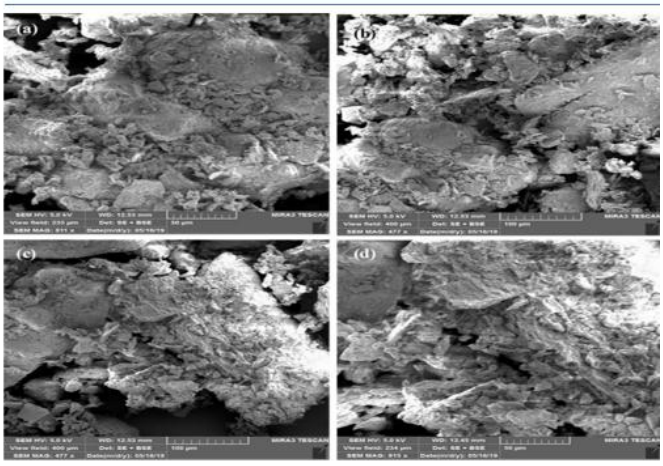


*Figure 1: SEM images of rice husk*

### FOURIER TRANSFORM INFRARED (FTIR) ANALYSIS

The FTIR spectrum of rice husk indicate complex surface by presence of several peaks with strong absorption band at 3272 cm-1 due to O-H stretching from hydroxyl group of caboxylic acid, while the band at 2900 cm-1 is due to C-H absorbance typical of organic material. The band 1603 cm-1 indicates the presence of cabonyl group via strong absorbtion, which further coroborates the band at 3272 cm-1 by an up field shift while the band at 1319 cm-1 coroborates the band at 2900 cm-1 in establishing the presence of C-H group through bending absorption. The band at 1033 cm-1 reveals the presence of an ether type C-O-R bond via stretching absorption as shown in Figure 2.

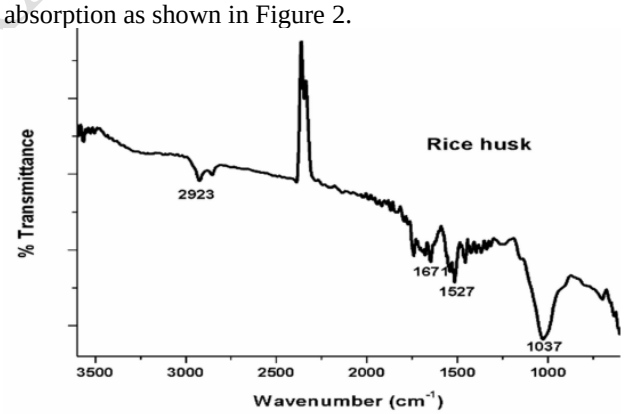


*Figure 2: FTIR curve for rice husk*

### CHARACTERIZATION OF THE WASTEWATER

Tannery wastewater was taken at ambient conditions from the storage pond of the Tanning Industries and analysed in accordance with HACH, 1997; APHA, 1998. The wastewater was later characterised in Chemistry Laboratory Federal College of Education, (Technical), Bichi, Kano, kano State, Nigeria to determine the following polluting parameters, Alkalinity, Total solids (TS), Total dissolved solids (TDS), Total suspended solids (TSS), Biochemical oxygen demand (BOD), Chemical oxygen demand (COD).

Where analysis was not immediately possible the sample was preserved in a refrigerator at 4$^{oc}$. At this temperature,

bacterials are inactive and biodegradation is inhibited (Ademoroti C.M.A 1996).

The analysis carried out on waste water sample before and after treatment were pH, using the electrometric method with the aid of a laboratory pH meter (Jenway model 3150) (Ademoroti C.M.A 1996). The temperature of the water was determined using the mercury in glass thermometer.

Electrical conductivity was measured by using HACH, TDS conductivity meter.

Nitrate was determined using the Brucine method (Ademoroti C.M.A 1996). Phosphate analysis was carried out using Kjeldahl method, sulphate ion was analyzed by turbidmetric method (Sheen R.T. Kahler H.L, Ross E.M 1935).

Dissolve oxygen (DO) was determined by alkaline –azide modification of Winkler' method (Winkler L.W 1988). Using dichromate reflux method (Dobbs R.A, Williams R.T 1963), chemical oxygen demand (COD) was determined. Biochemical oxygen demand (BOD) was measured using dilution method. Nitrogen and turbidity were determined using different standard methods.

OPTIMUM DOSAGE OF RICE HUSK IN THE TREATMENT OF WASTE WATER FROM TENNARY INDUSTRY

The optimum dosage of the rice husk in the treatment of wastewater from tennary industry was carried using reduction in COD.

Different adsorbent dosage was studied at 1-10g/l, the results shows that 5g was more effective in the reduction of COD, hence this is the optimum dose in the treatment of wastewater. This is the optimum amount of rice husk for the treatment. The result is as shown below.

OPTIMUM DOSAGE

| AMOUNT OF RICE HUSK | COD VALUE |
|---|---|
| Untreated | 1524mg/l |
| 1g | 1322mg/l |
| 2g | 1106mg/l |
| 3g | 965mg/l |
| 4g | 642mg/l |
| 5g | 463mg/l |
| 6g | 486mg/l |
| 7g | 502mg/l |
| 8g | 592mg/l |
| 9g | 608mg/l |
| 10g | 645mg/l |

*Table 4*

From the above it is observed that the COD values decreases gradually from 1524mg/l for the untreated to 463mg/l at 5g of the adsorbent, however at 6g of rice husk there was an increase, an indication that 5g gives the optimum value for treatment.

## IV. CONCLUSION

The study revealed that the tannery effluent contains pollutants that are beyond the WHO limit, hence, should be treated prior to disposal. The results obtained from the characterization of the adsorbents indicated that the prepared adsorbents have good adsorptive properties. The rice husk is an effective adsorbent in the treatment of tannery effluent prior to disposal with a COD, BOD, Nitrate and phosphate removal. Optimum operating conditions are concluded to be a contact time of 60 minutes at an adsorbent dosage of 5g at ambient room temperature.

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