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THE POTENTIALS OF *CHRYSOPHYLUM ALBIDUM* PEELS AS NATURAL ADSORBENT

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ABSTRACT

The physico-chemical properties and functional surface group of *Chrysophyllum albidum* peel was studied using standard method and Fourier Transformation Spectrocopy (FTIR) respectively to access its potentials as a natural adsorbent in treatment of wastewater. The IR spectra showed considerable functional groups such as –OH, -CH, C=O and C-O while the physico-chemical analysis shown, moisture (4.77%), pH (3.96), electrical conductivity (266µS), specific gravity (0.5739), bulk density (0.6424g/ml), ash (5.19%), fiber (19.81%), protein (3.75%), fat (14.35%) and carbohydrate (52.12%). The results indicates that peel of *C. albidum* could be used as a low cost alternative adsorbent to commercial adsorbent in the treatment of waste water.

KEYWORDS: Chrysophyllum albidum peel, physico-chemical properties, adsorbent, waste water.

INTRODUCTION

The high cost of commercial activated carbon restricts its application in treatment of waste water, so, there is need to undertake studies to substitute the costlier commercial activated carbon with the unconventional, low cost and locally available agricultural waste based materials.[1] Residues from agriculture and agro-industries are the non - product output from the growing and processing of raw agricultural products.[1]

Studies have shown that waste biomass of vegetables is a potential biosorbent for removal of heavy metals from aqueous solution because vegetable material represented particularly by cellulose and lignin, is a significant barrier of reactive groups which can bind metal ions.[2] *Chrysophyllum albidum* skin is one of indigenous agricultural waste that is being under-utilized. This work was designed to study the physico-chemical properties of *C. albidum* peel to ascertain its potential as an adsorbent in treatment of waste water.

EXPERIMENTAL

Chrysophyllum albidum fruit was bought at Relief market in Owerri North Local Government Area of Imo state, Nigeria. The skin was separated from the pulp. The sample (peel) was washed with distilled water, sun dried and ground. The ground sample was kept in a dark polythene bag and stored in a desiccator.

DETERMINATION OF PHYSICO-CHEMICAL PROPERTIES

Crude protein, Nitrogen, Carbohydrate, Ash, Crude fibre, Fat and Moisture contents were determined using the routine chemical analytical methods of Association of Official Analytical Chemists[3] while pH, electrical conductivity, specific gravity, bulk density, organic matter and carbon content were determined using the method reported by Okalebo *et al.*[4]

FTIR DETERMINATION

The surface functional groups of the *Chrysophyllum albidum* peel were studied by Fourier Transform Infrared (FTIR) Spectrophotometer (Shimadzu Corporation, IR Prestige 21 model). Aliquots quantity of the sample was mixed with a little quantity of KBr in the ratio of 1:10 (1mg:10mg) and finely pulverized in an agate mortar with pestle to homogenize the mixture. A little amount of the mixture was placed in a miniature press and compressed to form a disc or pellet of about 1mm thickness. This was placed in the appropriate sample holder. The sample holder, with sample was mounted on the sample compartment of the FTIR spectrometer and scanned within 4000cm^{-1} to 400cm^{-1}. The spectrum displayed after 16 scans in the view window was the printed out.

RESULTS AND DISCUSSION

Table 1: Physico-Chemical Properties of the Adsorbent

Parameter	***Value***
Moisture (%)	4.77

pH	3.96
Electrical conductivity (µS)	266
Specific gravity	0.5739
Bulk density(g/ml)	0.6424
Ash (%)	5.19
Organic matter (%)	5.6
Nitrogen content (%)	0.60
Carbon Content (%)	3.25
Fiber(%)	19.81
Protein(%)	3.75
Fat(%)	14.35
Carbohydrate (%)	52.12

The results of the physicochemical properties of the adsorbent are presented in Table 1. The moisture content of the adsorbent was found to be 4.77% and was lower than the moisture content reported in literature on some agricultural waste in Nigeria used in production of activated carbon.[5] The moisture content affects the adsorptive power of adsorbent as a wetted surface does not perform well because of interference of water molecules on the surface or edges of pores. Low moisture content is an indication of good adsorptive capacity, low microbial spoilage, deterioration and long shelf life.

Ash content is an indication of the presence of carbon compounds and inorganic component in the form of salt and oxides in the adsorbent.[6] The ash content of the sample was 5.19% and was found to be in the range of 3.95 – 12.67% of ash content of agricultural hulls reported by Oladayo.[5] Ash content has been reported to cause an increase in hydrophilicity and can have catalytic effects causing restructuring process during regeneration of used adsorbent.[6] Studies also showed that ash content of activated carbon range from 2-10%.[7] The high value of ash gives indication of high mineral (especially, the macro-minerals) content of the adsorbent. The low ash content indicate that the peels of *Chrysophyllum albidum* is free from inorganic substances which naturally hinder its adsorptive properties.

The fiber content value was found to be 9.81% for the adsorbent. Crude fiber measures the cellulose, hemicellulose and lignin content of a material. Lignin comprises polymers of phenolic acids and hemicellulose is made up of hetero-polymers of polysaccharides.[8] The high fiber content shows high content of cellulose, hemicellulose and lignin on the adsorbent and these polysaccharides materials has been used as adsorbent because of its high hydroxyl groups and high chemical reactivity of these functional groups.[9] The fiber content of skin of

Chrysophyllum albidum enhances its hardness and also aids in ability of removing insoluble particles from solution acting as a semi-permeable which traps heavy particles in solution.[6]

The organic matter was 5.6% and was higher than the ash content showing the presence of organic compounds such as cellulose, tannin, lignin, protein, lipids and carbohydrate. The organic matter plays a role in the adsorptive properties of a material such as water holding capacity, shear strength, nutrient contribution and water infiltration rate.

The carbon and carbohydrate value are 3.25% and 62.13% respectively. Carbon plays a vital role in the adsorption of substance due to its porous nature which is an indication that powdered carbon form of peel of *Chrysophyllum albidum* can effectively help in the removal of metallic ions and other particulate matters, odor and colours from aqueous media of water and waste water. The high carbohydrate content shows high presence of oxygen and hydrogen as constituent element and while in solution, form charges such as hydrogen and oxygen ions. The Oxygen ion which is negatively charge can attract metallic ions.[6] The nitrogen, fat and protein content of the adsorbent were found to be 0.60%, 3.75% and 14.35% respectively showing the presence of amine group in the skin of *Chrysophyllum albidum.*

The pH value was 3.96. The pH of the adsorbent was found to be acidic indicating the surface charge and the degree of ionization of the adsorbent. The high value of H^+ on the surface of the adsorbent shows an increasing tendency of the H^+ to desorp from the surface to the solution creating a vacant site for the adsorption of the metal to the biomass. The pH of the adsorbent observed shows that it has a high positive charge density.

Electrical conductivity is indicative of the ability of an aqueous solution to carry an electrical current. It correlates with adsorbent texture, cation exchange capacity, organic matter and salt concentration. The electrical conductivity was 266µS indicating high quantity of dissolved salts or ions in the adsorbent.

The bulk density was 0.6424g/ml. Low particle density is an indication of more organic components than heavy minerals. Bulk density of adsorbent is an essential parameter in determination of its application in water treatment system as its density determines its floatability and porosity of the material. It also determines the pore space of a material as material with low density have high pore space and high adsorption capacity. The density of the adsorbent depends on the nature of the material and the preparation process.[1]

FT – IR Spectroscopy

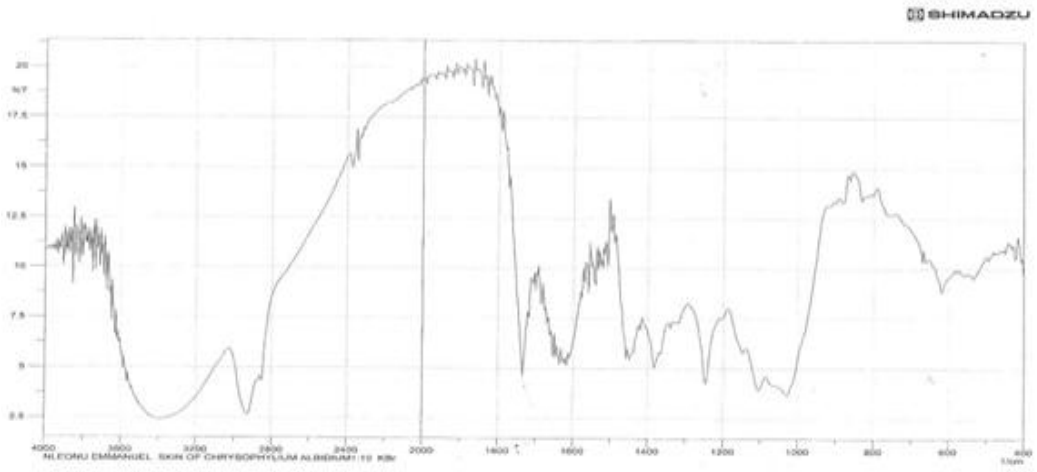

Fig. 1: FTIR spectra of skin of *Chrysophyllum albidum*

The FT-IR technique is an important tool in identification of some important functional groups, which are capable of adsorbing pollutant ions.[10] The FT-IR spectrum of the adsorbent is shown in Fig.1. The FT-IR spectrum of the adsorbent display a number of absorption peaks, indicating the complex nature of the studied adsorbent. It can be seen that hydroxyl (-OH) stretching vibration bands are at a wave number of 3400cm^{-1}. The peak between 2800 - 3000cm^{-1} is due to the asymmetric stretch of aliphatic chains (-CH). The peaks between 1700 -1800cm^{-1} are due to C=O stretching that can be attributed to the presence of carbonyl compounds in the peel of *Chryosophyllum albidum*. The vibrations around 1400 - 1500cm^{-1} could be due to aliphatic and aromatic (C-H) groups of methyl, methylene and methoxy groups. The intense peak at 1200 - 1300cm^{-1} corresponded to the C-O stretching of alcohol or carboxylic acid. The spectrum of *Chrysophyllum albidum* shows more number of total basic groups compared to acidic groups which will promote uptake of metal ions.

CONCLUSION

The result of physico-chemical and IR showed that the inherent compositions of *Chrysophyllum albidum* skin could serve as a natural adsorbent for its application in water and waste water treatment system.

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