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Full Length Research Paper

Treatment of Palm Oil Mill Effluent Using Modified Powdered Cherry *(Chrysophyllum albidium)* Seed Shell Carbon

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ABSTRACT

Cherry seed shell *(Chrysophyllum albidium)* was de-shelled, air-dried and then activated with 50% saturated ammonium chloride solution before carbonizing in a muffle furnace. The powdered activated carbon obtained was characterized in terms of the pH, bulk density, volatile content, ash content, moisture content and surface area. Palm oil mill effluent was sourced for in a local drowling press; it was characterized and treated using powdered activated carbon from cherry seed shell. The result of the powdered activated carbon characterization (pH, 7.1, bulk density, 0.73g/ml, moisture content, 5%, volatile content, 6.06%, ash content, 6.93%, and surface area 1.9x 10-2g/mgI_2) revealed that the carbon can favourably compete with some commercial grade activated carbons. The result of the parameter studied before and after treatment of the effluent shows that there was a reduction in turbidity values from 17.54mg/l-13.31mg/l, Total solids values from 6748mg/l-4390mg/l, the centrifuged raw effluent had Total solids value of 3124mg/l – 1056mg/l, Total suspended solids raw effluent value of 6396mg/l-4084mg/l, the Total dissolved solids values of raw effluent was 352mg/l-306mg/l. There was also a decrease in the Biochemical Oxygen Demand and Chemical Oxygen Demand values from 6100.43mg/l, 12000.43mg/l-5100.31mg/l, 10000.35mg/l respectively .This results show that powdered activated carbon from cherry seed shell is effective in the treatment of waste water such as palm oil mill effluent.

Keywords: Activated carbon, cherry seed shell, activation and adsorption.

INTRODUCTION

Health and environmental issues arising from waste effluents are universally acknowledged problems. The usually complex compositions of waste waters lead to intricate treatment processes with accordingly high costs, which are impractical given the large volumes of waste produced both by domestic use and industry. It is therefore necessary to find cheap and simple decontamination materials and methods.

Adsorption and ion exchange are among the most studied: both techniques have been effectively applied, and the latest research on alternative/modified adsorbents and ion exchangers spans a wide range of different materials. Low costs, availability and simple methods for synthesis and application have been the main parameters considered when selecting materials to be applied in this area. Special effort has been devoted to finding alternative sources of activated carbon, given its effectiveness and the simple techniques for its production.

Activated carbons are some of the most widespread agents for the treatment and purification of water. Their high porosities, from macro to microporous structures, make them efficient adsorbents to trap low molecular weight chemicals such as metal ions, dyes and other organic compounds. This is achieved through adsorption processes, where the atoms and molecules are fixed to the carbon surface via physical interactions or chemical bonds.

Activated carbons are produced by treating organic precursors at high temperatures. This removes volatile components such as water and biomass, leaving void spaces which form the characteristic porous structure.
Several workers have reported on the potential use of agricultural by–products as good substrates for the treatment of wastewaters such as fly ash (Nascimento et al., 2009), lignite (Ucurum, 2009), phosphate rock (Saxena and D'Souza, 2006), kaolinite-based clays (Hizal and Apak, 2006), red muds (Wang et al., 2008), sawdust (Sciban et al., 2007), loess soil (Wang et al., 2009), green algae (Gupta et al., 2001), and husk of wheat and rice (Aydin et al., 2008) etc.

This process attempts to put into use the principle of using waste to treat waste and become even more efficient because these agricultural by–products are readily available and often pose waste disposal problems. Hence, they are available at little or no cost, since they are waste products. This makes the process of treating wastewaters with agricultural by–product adsorbents more cost effective

Cherry seed shell (Chrysophyllum albidium) is a dominant canopy tree of low land mixed rain forest, sometimes riverine. It is widely distributed from West Africa to the Sudan with an east limit in Kakamega forest, Kenya. In Nigeria, Chrysophyllum albidium is distributed throughout the southern part.

Palm oil mill effluent commonly refers to large quantities of polluted waste water generated during the course of palm oil production. The palm oil mill effluent comprises a combination of waste water from three main sources in the course of production.

The three main sources of liquid effluent from a conventional palm oil mill are sterilizer condensate, hydrocyclone waste and separator sludge.

This present study is aimed at investigating the potentials of activated carbon from cherry seed shell in the treatment of palm oil mill effluent.

To the knowledge of the authors, there are no reports of previous attempt to produce activated carbon from cherry seed shell for the treatment of palm oil mill effluents.

MATERIALS AND METHODS

Palm oil mill effluent was sourced from a local oil palm mill in Igueben, Edo State, Nigeria. The representative samples were obtained using the composite sampling techniques. The dissolved oxygen was fixed by adding to the sample the winkler solution. Cherry seeds were obtained from Igueben market in Igueben Local Government area of Edo State and air-dried. The air-dried agricultural residue was cut into small pieces and steeped in aqueous saturated solution of ammonium chloride at ambient temperature (28-31°C) for 24 hours and thereafter pyrolyzed in a muffle furnace at 300°C for 2 hours. The detailed experimental procedure for the preparation of activated carbon from agricultural residues was given previously (Okieimen et al, 2005).

The powdered activated carbon prepared from cherry seed shell was characterized in terms of pH, bulk density, (Ahmedna et al, 1997), surface area, (Okieimen et al 1991), ash content, volatile content, and moisture content. The detailed experimental procedures for the characterization of activated carbon were given in a previous publication.

The palm oil mill effluent (POME) was characterized in terms of the pH, dissolved oxygen (DO), Chemical oxygen demand (COD), Biological oxygen demand (BOD), Electrical conductivity, Total dissolved solids (TDS), Total suspended solids (TSS), Total solids (TS), Turbidity, oil and greases, heavy metals, calcium, Magnesium, Nitrogen and ammonia, using standard methods.

The adsorptive properties of the cherry seed shell carbon were determined from the treatment of the palm oil mill effluent. The method involved the determination of the listed parameters before and after treatment with the activated carbon using standard procedures (APHA 1971). In a typical experiment, a carefully weighed amount of the activated carbon (about 5g) was mixed with 100ml of raw palm oil mill effluent in a bottle and shaken for thirty minutes after which the mixture was centrifuged to separate the powdered chrysophyllum albidium seed carbon from the effluent, filtered and the treated effluent was analyzed

RESULTS AND DISCUSSION

Table 1: The characteristics of the powdered activated carbon prepared from cherry seed shell.

Activating Agent	pH	Bulk Density (g/cm^3)	Surface Area (mgI_2/g)	Ash(%)	Volatile(%)	Moisture (%)
NH_4Cl	7.1	$0.732 \pm 3.3 \times 10^{-5}$	$1.9 \times 10^{-2} \pm 0.003$	6.93	6.06	5.00

The values of the pH of cherry seed shell carbon are within the generally acceptable range or values (6-8) in many applications. Activated carbons with extreme pH values are capable of increasing or decreasing pH of slurry to induce undesirable physical/ chemical changes; for instance in cane sugar refining, carbon with low pH values could cause the inversion of sucrose to non-crystallisable sugars causing lower yields, while alkaline carbon could cause decolouration through alteration of molecular structure of sugar impurities. The values of pH of cherry seed shell carbon reported here are comparable with the values reported for rubber seed shell carbon (Okieimen et al 2005) and rice husk carbon (Okieimen et al 2005).

Bulk density is important when activated carbon is to be removed by filtration, because it determines that amount of carbon that can be contained in a filter of given solids capacity. Carbons with an adequate density also help to improve filtration rate by forming an even cake on the filter surface (Ahmedna et al 2000). The values of bulk density of cherry seed shell carbon reported in this study are well within the acceptable range for powdered activated carbon in many applications (B.D $0.73g/cm^3$) .

The surface area of cherry seed shell carbon was determined by the iodine adsorption method: which is a widely used routine procedure for the determination of surface area of powders. Large surface area is a requirement for good adsorbent. Surface area is a single most important characteristics of activated carbons designed for adsorption of compounds from liquid media. Report of previous studies (Okieimen et al 1991) that attempted to correlate surface area measurements by different methods suggests that the values of iodine number obtained for cherry seed shell carbon represent a fairly large surface area. The values of surface area of cherry seed shell carbon are comparable with those reported for rubber seed shell carbon (Okieimen et al 2005) and rice husk carbon (Okieimen et al, 2005)

Table 2: The characteristics of the raw and treated palm oil mill effluent using powdered activated carbon prepared from cherry seed shell.

Parameters	Raw POME	Raw centrifuged POME	Raw POME treated with carbon	Raw centrifuged POME treated with carbon
pH	4.2	4.4	4.5	5.0
EC, µs/cm	812	2573	716	1055
TDS, mg/l	352	1270	306	600
TSS, mg/l	6396	1854	4084	456
TS, mg/l	6748	3124	4390	1056
Turbidity, mg/l	17.54	14.76	13.31	10.56
Ammonia, mg/l	0.175	0.621	0.101	0.362
Nitrogen, %	0.45	0.81	0.03	0.23
Oil/Grease, mg/l	690.45	610.60	460.86	430.64
DO, mg/l	0.00	0.00	0.00	0.00
BOD, mg/l	6100.45	1900.75	5100.31	200.10
COD, mg/l	12000.45	4000.22	10000.35	2100.10
Ca, mg/l	2.86	5.47	1.03	3.75
Mg, mg/l	1.97	3.66	1.36	2.43
Fe, mg/l	2.97	3.96	2.05	1.54
Zn, mg/l	0.74	1.03	0.55	0.42
Mn, mg/l	0.21	0.33	0.16	0.29

Table2 shows the treatment levels of the POME by cherry seed shell carbon measured in terms of the parameters listed. The pH increases as the level of treatments increases from 4.2 for the raw POME to the 5.0 for the POME treated with the activated carbon. The increase in pH is due to increased surface area of the effluent water. The pH of the raw POME shows that it is not fit for disposal into the immediate environment as it could cause certain environmental hazard or pollution. The treatment shows the ability of the cherry seed shell modified to effectively treat effluent water. The TS, TSS and TDS decrease as the treatment increases as shown in Table 2, this show that there is a considerable reduction of dissolved solids. The result were better with the centrifuged treated effluent. It was observed that nitrate ion was present in the raw POME in a relatively minute percentage, which is capable of causing metheamoglobinanca in infant and as such should be treated. On treatment with the carbon, the nitrate ion reduces drastically to 0.03% which is insignificant. The BOD and the COD reduces substantially on treatment with the activated carbon which is an evidence of improved water quality. Also worthy of note is the fact that dissolved and suspended substances contributes to high turbidity values of any waste water, hence the turbidity values the centrifuged palm oil mill effluent gave better result compared to the raw. The ability of active carbon to remove organic compounds from aqueous solution depends on the structure/surface chemistry of the carbon and the polarity of the organic compound (Okieimen et al ,2005). Activated carbon is inherently hydrophobic, except it is subjected to post-pyrolysis oxidation process, and would be expected to show minimal tendency towards interaction and removal of polar compounds from aqueous solution. The conditions of the preparation of the activated carbon used in this study allowed a degree of oxidation which has been shown to contribute to the development of surface oxygen groups that account for the removal of polar compounds (Okieimen et al, 2005). The results in Table 2 show that the activated carbon from cherry seed shell is capacle of effectively reducing the levels of heavy metals and inorganics from the effluent.

CONCLUSION

Activated carbon prepared from cherry seed shell carbon using ammonium chloride as activating agent has been characterized and evaluated in terms of adsorption of POME. The results show that the activated carbons are effective in the treatment of effluents

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