



Synthesis and Physiochemical Parameters of a Bio-Derived MgO Powder from Locust Beans Leaf Extract for Removal of Bod from Tannery Wastewater

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ABSTRACT

A study of the performance of BOD and physiochemical parameter degradation via adsorption was taken using Bio-derived MgO powder (MgO-p), synthesized using extract of locust beans and Mg (NO₃)₂ at 500oC following a green approach. The reduction efficiency of the MgO-p was evaluated in the presence of raw tannery wastewater by application of treatment time, adsorbent dosage, pH and concentration as parametric factors, and physiochemical properties such as TDS, EC, ORP and pH. Result obtained were compared to environmental regulatory limits (WHO and NESERA) on the reduction of biological oxygen demand (BOD) of wastewater from coffee processing plant using activated carbon made from Locust Beans extract with 99.02% and 99.35% removal at optimum operating conditions, percentage removal efficiency recorded ranged from a minimum of 5.71 to a maximum of 100 % at an initial concentration of 14.00 mg/l. Hence, the adsorption become constant and additional adsorbent made significant contribution. This study reveals that MgO powder is better applied as BOD reductants over physiochemical parameter for spent tan liquor.

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INTRODUCTION

Tannery wastewater is highly polluted in terms of its Biological Oxygen Demand (BOD), Suspended Solids (SS), nitrogen, conductivity, sulphate, sulphide and chromium (Mondal *et al.*, 2015) and in most developing countries tannery effluents are discharged directly into sewers or water bodies without treatment (Verheijen *et al.*, 2011). High BOD content of an effluent affects the survival of gill breathing animals of the receiving water body and high COD value indicate toxic State of the wastewater, including the presence of biologically resistant organic substances. High level of ammonia (NH₃) is toxic to aquatic organisms and excess nitrogen will cause eutrophic condition.

The high salinity and Total Dissolved Solids of effluents may result in physiologically

stressful conditions affecting some species of aquatic organisms due to alterations in osmotic conditions. Changes in the ionic composition of water can also eliminate some species while promoting population growth of others (Weber *et al.*, 2017). The manufacture of leather has evolved into a significant source of livelihood in many industrialized and developing countries, (Bosnic *et al.*, 2010). As estimated, the total wastewater discharge from tanneries runs to about 400 million m³ each year.

The industry has been painted negatively in the society owing to its high pollutant composition, health and environmental implication is a negative to the sitting of the leather industry. The difficulty in treating tannery effluent owes it to the complex nature of the wastewater produced, leading to various environmental regulations and

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laws in many developing countries being passed especially in the last ten years. Adsorption is a phenomenon that occurs on the surface or pores of a solid (sorbent), it is characterized by the available surface area and is a function of the partial pressure (or concentration in aqueous solutions) of a chemical species (solute) (Chiou 2012). Nanomaterials exist in a variety of forms, including nano-wires, nano-tubes, films, particles, quantum dots and colloids, all having excellent liquid treatment potential (Edelstein and Dutta 2014). Nano-adsorbent can be produced using atoms of elements that are chemically active and having high adsorption capacity on the surface of the nano-material (Deepracha and Ogawa 2019). Activated carbon, silica, clay materials, metal oxides and modified compounds in the form of composites are examples of nano-adsorbents employed for wastewater treatment (El-Saliby *et al.*, 2018).

METHODOLOGY

Collection and Preparation of Leave Extract

Fresh leaves of Lucust beans was collected from the Botanical guarding ABU Zaria, The leaves was washed thoroughly with tap water to remove sand and other solid particles and then rinsed severally with distilled water, chopped into tiny bits, air-dried for 12 days, grounded to powder using mortar and pestle. A-50 g of powdered leaves was weighed out and added to 400 ml of distilled water in a 1000 ml conical flask and stirred under heat at 80 °C for 30 min. The extract was mixed and centrifuged for 10 min and then filtered, the filtrate was kept in the refrigerator for use in the synthesis of MgO-NP (Saikia *et al.*, 2015).

Green Synthesis of MgO nanopowders

An aliquot of 150 ml of the aqueous plant extract was mixed with 20 ml of Mg (NO₃)₂.6H₂O in a 400 ml conical flask. The mixture was vigorously stirred for 20 min at ambient temperature, forming milky precipitates and was collected by centrifugation. The precipitates was washed with ethanol, rinsed with distilled water, and dried at 90 °C for 3 hours. The dried precipitate powder was heated in an oven at 500

°C for 2 hours to form MgO nanopowder. (Feka *et al.* 2021)

Collection of tannery effluent

The tannery effluent was collected in NILEST Tannery by spot (grab) sampling method as detailed elsewhere (UNIDO, 2016). Collected wastewater was filtered and stored in a cooling set, at freezing temperature (below 4 °C) till use.

Sorptive Treatment Experiment via Batch and Fixed-bed System

The tannery wastewater was treated according to the sorptive remediation method by Oladipo *et al.*, (2017). The sorption experiment was carried out at ambient temperature under different experimental conditions (contact time and adsorbent dosage). Effect of contact was achieved by contacting 50.0 mg of MgO-PS with 50 ml tannery wastewater of initial BOD of 91.8 mg/l. The experiment was carried out in sealed conical flasks at 20 min interval between 20 to 100 min per experiment batch. Samples was drawn every 20 min, filtered and analyzed. The above experimental procedures was carried out in triplicate from which the mean result was calculated. The percentage removal BOD concentrations were validated by using the equations:

$$R (\%) = \frac{(BOD_i \times V_i) - (BOD_f \times V_f)}{BOD_i \times V_i} \times 100 \text{ ----- (1)}$$

$$R (\%) = \frac{(COD_i \times V_i) - (COD_f \times V_f)}{COD_i \times V_i} \times 100 \text{ ----- (2)}$$

Where: *BOD_i* and *BOD_f* are the initial and final concentrations at a given time, respectively and *V_f* are the volumes of the untreated and treated wastewater solutions, respectively.

Determination of BOD

250ml of the sample was added into a BOD bottle and incubated at 20 °C for 5 days. After 5 days, 2ml of manganous sulphate solution was added, 2ml of alkali-iodide-azide reagent was added well below the surface of the liquid, the BOD bottle was stoppered with care to exclude air bubbles and the mixture was mix by inverting the



bottle several times. The mixture was allowed to settle and 2ml of concentrated H₂SO₄ solution was added and the mixture was gently mixed again by inversion. 200ml of the mixture was measured and poured into a conical flask, 2ml of starch solution was added as indicator and the

mixture was titrated with 0.025N Sodium Thiosulphate (Na₂S₂O₃) until a sharp colour is obtained as the end point.

RESULTS AND DISCUSSION

Table 4.1: Result for Control

TDS (ppm)	EC (S/m)	pH	ORP (mV)	BOD (mg/l)
1590	1.0	4.35	179	14.0

Table 4.2: Effect of Concentration

Concentration	TDS	EC	pH	ORP	BOD
2.5ml	0020	0.03	3.92	189	1.4
5ml	0310	0.44	1.67	304	1.5
10ml	5070	0.09	4.40	204	0.7
20ml	2840	4.09	4.01	194	1.0

Table 4.3: Percentage Removal Efficiency

Concentration	TDS %	EC %	pH %	ORP %	BOD %
2.5ml	98.7	97	9.8	-0.55	90.0
5ml	80.5	56	61.6	-670	89.3
10ml	-218.8	91	-1.14	-15.08	95.0
20ml	78.6	-309	5.97	-1.11	92.9

Table 4.4: Effect of Time

Contact Time (Min)	TDS	EC	pH	ORP	BOD
10	16490	16.47	3.68	202	1.4
20	18140	18.11	1.80	059	0.1
40	4950	6.86	3.68	197	0.1
80	1688	18.99	4.04	204	0.1

Table 4.5: Percentage Removal Efficiency

Contact Time (Min)	TDS	EC	pH	ORP	BOD
10	3.71	-1547		-12.84	90.0
20	-14.08	-1711		67.03	99.3
40	-211.3	-586	13.40	-7918	99.3
80	-211.3	-586	7.12	-13.96	99.3

Table 4.6: Effect of Adsorbent Dosage

Adsorbent dosage	TDS	EC	pH	ORP	BOD
2mg	16690	0.26	4.28	180	0.9
4mg	1812	0.16	1.76	299	0.7
8mg	1720	0.15	3.48	206	1.4
16mg	1711	0.10	4.46	181	3.8

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Table 4.7: Percentage Removal Efficiency

Adsorbent dosage	TDS	EC	pH	ORP	BOD
2mg	-4.96	74	1.60	-0.55	-125
4mg	-13.96	84	3.95	-6.70	-75
8mg	-8.17	85	2.0	-15.08	-250
16mg	-7.61	90	-2.52	-1.11	-850

Table 4.8: Effect of pH

pH	TDS	EC	pH	ORP	BOD
2	0080	0.11	2.00	257	0.9
5	0020	0.02	5.0	235	5.1
8	0010	0.02	8.0	233	2.4
14	0010	0.02	14.0	237	0.9

Table 4.9: Percentage Removal Efficiency

pH	TDS	EC	pH	ORP	BOD
2	94.9	89	54.02	-34.57	-125
5	98.7	98	-14.94	-31.2	-1175
8	99.3	98	-83.90	-30.16	-500
14	99.3	98	-2.21	-32.40	-125

Physicochemical Properties of Wastewater

The results of the physicochemical properties of raw wastewater (RW) and treated wastewater (TW) are presented in Table 4.1 and 4.2. Effect of concentration with an initial pH of treated wastewater is presented in table 4.2 the pH of treated wastewater is documented with varying concentration of 2.5ml, 5ml, 10ml and 20ml. The result of the pH was 3.92, 1.67, 4.40 and 4.01 respectively.

The Electrical Conductivity (EC) and Total Dissolved Solids (TDS), of treated effluent increased with increase in time up till 120 min contact time when a slight decrease was observed. There was increase in total solids (TS) due to high increase in TDS. The increase in these parameters was due to the partial dissolution and possible interaction between the activated carbon from *Cordia millenii* and the constituents of the treated wastewater. The result is in conformity with the findings of Bolade and Sangodoyin, (2018). The increase in electrical conductivity of the wastewater could be attributed to residual salts from activation of precursor and hydrogen ions found in the precursor material (*Cordia millenii*). The zinc chloride salt used to activate the biochar contained zinc ions (Zn⁺) and chloride ions

(Cl⁻) held together in crystals. These ions broke apart into aqueous solution of zinc and chloride ions which conducted electrical current in water. Conductivity is dependent on water salinity and total dissolved solids (Talley, 2000). According to WHO, the pH of wastewater and drinking water is in the pH range of 6.5–8.5 and 7. The electrical conductivity of wastewater at >1000 µS/cm indicates contaminated water. After the treatment of wastewater its value reduced significantly which was within the WHO standard and National Environmental Standards Regulatory and Enforcement Agency.

ADSORPTION STUDIES

Effect of Concentration and comparative adsorptive removal of BOD

The effect of concentration on adsorptive treatment is presented in Tables 4.2. An initial concentration of 14.00 mg/l was documented for BOD at varying concentration of 2.5ml, 5ml, 10ml and 20ml. The BOD concentrations recorded after each treatment for were 1.4, 1.5, 0.7 and 1.0mg/l respectively. The results recorded were below the WHO (world health organization) and NESREA (National Environmental Standards and Regulations

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Enforcement Agency) environmental limits of 30 mg/L. The percentage removal efficiency calculated and reported for the respective BOD concentrations was < 1 in all. This is in close agreement with findings by Devi *et al.*, (2008) on the reduction of biological oxygen demand (BOD) of wastewater from coffee processing plant using activated carbon made from Locust Beans extract with 99.02% and 99.35% removal at optimum operating conditions.

Effect of Time

The lowest percentage removal for BOD was 0 %, and highest was < 1%. The removal of BOD was mostly low but improves progressively with increasing contact time. At 20 min intervals, BOD reduction from an initial concentration of 14.00 mg/l decreased to 6, 4, 4 and 4mg/L; corresponding to contact times of 10, 20, 40 and 80 min respectively.

Effect of Adsorbent Dosage

Results presented in Table 3 shows that increasing adsorbent dosage will influence BOD removal efficiency at an optimum contact time of 1hr. The percentage removal of < 1 % in all on application of corresponding adsorbent masses of 2, 4, 8 and 16mg, BOD at an initial concentration of 14.00 mg/L was studied (Table 4.6), with the result presenting the effect of adsorbent dosage on BOD removal; percentage removal efficiency recorded ranged from a minimum of 5.71 to a maximum of 100 % at an initial concentration of 14.00 mg/L. Hence, the adsorption become constant and additional adsorbent made significant contribution.

Effect of pH

The pH varies from 2-14 adsorbent dose of 50 mg, time of 60 min the nano particle adsorption increases at pH 2 and decrease at pH14 the removal of contaminant shows a steady increase with the pH value at pH 2 before the adsorption becomes steady.

CONCLUSION

To the best of our knowledge, this study represents comprehensive investigation utilizing

the green synthesis of MgO powder leaded with Locust Beans extract with highlight of its volatile aroma extracted by advance method. MgO powder exhibited a promising antioxidant and anti-aging activities in does dependent manner.

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