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Tannery Wastewater Treatment Using Activated Carbon From *Moringa Oleifera* Pods

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Abstract: *Moringa oleifera pod, a low-cost agricultural waste was utilized to produce activated carbon which was used in the treatment of Chromium ion in wastewater effluent from the Tannery section of the Nigerian Institute of Leather and Science Technology (NILEST), Samaru, Zaria, Kaduna State, Nigeria, which has several components that constitute pollution in the environment. The effect of time and temperature on the quality of treatment and also the effect of agitation on the quality of treatment achieved using the activated carbon produced were assayed. The activated carbon showed a significant ability in removing Chromium ions from samples of tannery waste water. Higher efficiencies were observed with increase in temperature, time length of experiment, and higher magnetic stirring speed. The stream from the Tannery section is having high concentration of Chromium ion, which is highly carcinogenic when exposed to the environment if not treated properly. This work therefore, suggests that the availability of moringa oleifera pods in the surrounding communities should be utilized in solving this environmental pollution.*

Keywords: *Moringa oleifera pods, Temperature, Chromium, Activated carbon, wastewater effluent.*

I. Introduction

Moringa oleifera plant is a medium sized tree species which has gained importance due to its multipurpose usage and well adaptability to dry and hot climates especially in rural communities in northern Nigeria. The tree is a perennial plant that grows fast, with flowers and fruits appearing within 12 months after planting and grows up to a height of 5–12 meters with branches extending between 30 and 120 cm [1]. Due to its medicinal and nutritional properties, Moringa oleifera pods, seeds, and oil are widely consumed in Northern Nigeria [2, 3].

Biosorption of heavy metals from aqueous solutions is a process that is effective in the removal of contaminants from aqueous effluents. Adsorbent materials derived from low-cost agricultural wastes like the moringa oleifera pods can be used for the effective removal of heavy metal ions like chromium from wastewater streams [4].

Moringa oleifera seeds have been traditionally utilized in many rural areas of Africa [4] and Asia [5] for drinking water purification as they possess strong coagulation properties for sedimentation of suspended mud, turbidity and exert a disinfecting effect on pathogens. This is widely practiced in remote areas of West and East Africa. However, there is a very minimal utilization of moringa oleifera pods in water treatment as they are considered as agricultural wastes.

Composition of Moringa fresh leaves is between 19.3% and 26.4% crude protein in dry matter [6, 7, 8]. The leaves have a negligible content of tannins and saponin and no trypsin and amylase inhibitors or cyanogenic glycosides [6]. The seeds present a protein mass composition of 29.36% [9]. The shelled and non-shelled seeds contain approximately 37% and 27% of protein, respectively. The adsorptive capacity of Moringa oleifera is highly potent because it contains substantial quantities of cellulosic interlinked with lignin in their structure. Lignin is a complex bio-polymeric heterogeneous molecule which is a polyfunctional compound with methoxyl, hydroxyl-aliphatic, carboxyl and phenolic functional groups [10, 11]. It has an aromatic, three-dimensional polymer structure with an infinite apparent molecular weight, thus, favoring biosorption as one of the promising techniques to treat chromium-containing wastewaters [12] through the use of Moringa oleifera pods as low-cost adsorbent. This structure makes lignin insoluble in water. Studies have revealed that lignocellulotic plants can be used to remove a wide range of heavy metals [13, 14, 15] from aqueous effluents with high removal efficiencies.

The active agents in Moringa oleifera extracts responsible for coagulation were found to be the cationic polypeptides [16, 17]. the isolation from Moringa oleifera of a flocculating protein of 60 residues with isoelectronic point above pH 10, high levels of glutamine, arginine and proline with the amino terminus blocked by pyroglutamate, and flocculants capacity comparable to a synthetic polyacrylamide cationic polymer. However, a non-protein coagulant was also reported but not characterized [18, 19].

The objectives of this work is aimed at utilizing a low-cost agricultural waste, moringa oleifera pod in the production of activated carbon and its application in treatment of chromium in waste water effluent, and also utilize the availability of moringa oleifera pods in the surrounding communities to solve environmental pollution.

II. Materials And Methods

2.1. Preparation of sample

Moringa oleifera pods were obtained at Nigerian Institute of Leather and Science Technology (NILEST), Zaria. It was sun-dried for four consecutive days to dehydrate it completely. The sample was crushed using pestle and mortar with average particle mesh size of 2mm, which can be authenticated by sieving using a 10-32 mesh (2.0mm).

2.2. Chemical activation and carbonization

The method as outlined by [20]. Six grams (6g) of ground moringa oleifera pods were soaked in 50 ml of 50% phosphoric acid solution at 30°C for 48 hrs. After 48 hrs, the phosphoric acid was filtered out and the activated raw material was carbonized in a muffle furnace at 300°C for 2 h in nitrogen atmosphere. After cooling, each of the carbonized materials was washed with 200 ml hot distilled water, and then dried for 2 h at 120°C. The dried carbon was then weighed to determine percentage yield, which is mathematically expressed as;

Percentage Yield (%) = Yield (g)/mass of raw material (g) * 100.

2.3. Treatment of the tannery waste water

A mass of 50mg of the produced activated carbon was weighed and put into a measured 100ml of the tannery wastewater in a 250ml beaker. The beaker together with its content is then placed on a rotating heating mantle. Both the heating mantle and the load were placed inside a fume cupboard.

The magnetic stirrer is then connected to a power source and put on as well as the fume cupboard. The treatment was done at 3, 5, and 7 revolutions per second (rps) for 10, 15, 20, 25 and 30 minutes for various samples. The procedure was repeated at 20, 40, 60, 80, and 100^{O}C respectively. After the treatment, the content was filtered and prepared for analysis.

After the treatment of the tannery waste water with the produced activated carbon, the samples were filtered and the filtrates were analyzed with the aid of an Atomic Absorption Spectrophotometer at the Multi-user Research Laboratory, Department of Chemistry, Ahmadu Bello University, Zaria, Nigeria.

III. Results And Discussion

Table 1 shows effects of temperature on chromium ion removal using moringa oleifera pods at different stirring speed. The result shows increased treatment efficiencies with increase in temperature and stirring speed. The result is in agreement with [21] on the effect of temperature on cadmium (II) removal using Moringa oleifera, reported increase in treatment efficiencies at higher temperature and stirring speed.

Table 2 shows the effects of treatment time on chromium ion removal using moringa oleifera pods at different stirring speed. The result shows higher treatment efficiencies with increase in time length of experiment and the magnetic stirring speed. The result is in agreement with similar work carried out by [21], which reported higher adsorption properties of moringa oleifera on cadmium, and also reported higher treatment efficiency of moringa oleifera with increase in time length of experiment.

Table 1: Effects of Temperature on Chromium ion removal using Moringa Oleifera Pods at different stirring speed.

Temperature (^{O}C)	Percentage of adsorbed Chromium ion (%)		
	3 Revolutions per second	5 Revolutions per second	7 Revolutions per second
20	2.10	4.90	11.50
40	21.40	23.10	26.50
60	39.60	46.90	52.20
80	78.35	78.90	79.70
100	81.50	84.40	85.10

Table 2: Effects of Treatment time on Chromium ion removal using Moringa Oleifera Pods at different stirring speed.

Time (minute)	Percentage of adsorbed Chromium ions (%)		
	3 Revolutions per second	5 Revolutions per second	7 Revolutions per second
10	1.1	21.00	42.50
15	3.4	36.10	59.50
20	9.50	55.30	72.50
25	54.20	73.40	86.10
30	74.50	90.40	96.10

From the fig. 1 and 2 below, there exist clear differences in the extent of treatment of chromium ions in the waste water effluent analyzed with changes in temperature, stirring speed and time length of experiment.

Similar to the work of [21] on lead removal from wastewater using moringa oleifera seed, this study further shows that as the temperature and/or time length of the experiment increases, there is a clear increase in the percentage of chromium ions removed from the tannery waste water samples at all the levels of magnetic stirring. Also, at each particular time length of experiment, the fig. 2 depicts increase in the percentages of chromium ions removed from the tannery waste water samples with increase in the magnetic stirring speed.

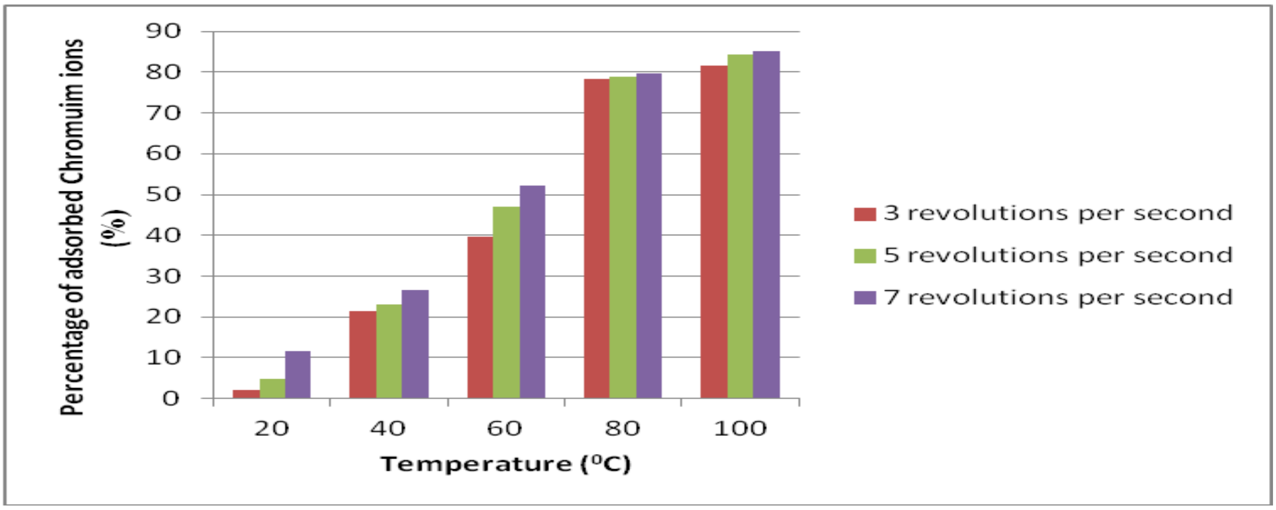

Figure 1: Chart displaying Effects of Treatment time on Chromium ion removal using Moringa Oleifera Pods at different stirring speed.

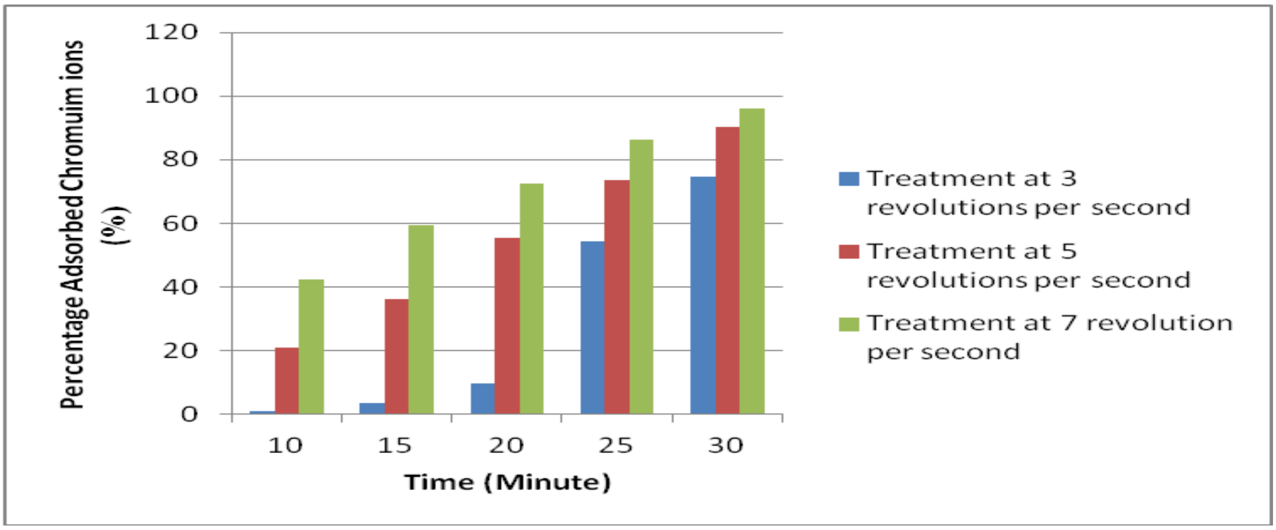

Figure 2: Chart displaying Effects of Treatment time on Chromium ion removal using Moringa Oleifera Pods at different stirring speed.

IV. Conclusion

The activated carbon produced from Moringa oleifera pods, a low cost agricultural waste showed a significant ability in removing chromium ions from samples of tannery waste water analyzed, and it therefore, suggests that the availability of moringa oleifera pods in the surrounding communities should be utilized in solving this environmental pollution.

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