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Removal of Colour from Textile Wastewater Generated by Local Dyers in Maiduguri using Millet Straw and Rice Husk Adsorbents

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Abstract
This study attempts to investigate the suitability of agricultural by-products based activated carbon as adsorbents for the treatment of textile wastewater. The chemical treatment adopted in the study is simple and qualitative. Two low– cost adsorbents namely: Rice husk (RH), and Millet straw (MS) were studied. The initial concentration of Colour in the wastewater was 25570 pt/co. Colour removal with the adsorbents were investigated under two conditions namely: constant adsorption time with varying dosage of adsorbents and constant adsorbent dosage with varying adsorption time. For MS, the optimum removal of colour at constant adsorption time of 2hrs was 95.9% and 94.5% at constant dosage consequently. For RS, the optimum removal of colour at constant adsorption time of 2hrs was 94.5% and 75.8% at constant dosage. Maximum saturation was attained for both adsorbents at 7 hrs contact period. The results of the adsorption study, shows that RH and MS adsorbents can serve as coagulants for removing colour from textile wastewater. The MS powder in particular, was discovered to have a high adorptive capacity.
Keywords:Textile wastewater, colour removal, Rice husk, Millet straw,adsorbents.

1 .INTRODUCTION

The textile industry is one of the most complicated among manufacturing industries. Wastewater generation and treatment are part of the problems faced by textile manufacturers. Main pollution in textile wastewater come from dyeing and finishing. These processes require the input of a wide range of chemicals and dye stuffs, which generally are organic compounds and are of complex structure. The processes start with fiber production followed by spinning, sizing, weaving, dyeing, printing and finishing. The combination of these result in wastewater from a textile plant containing many types of pollutants. The dyeing and finishing operations are such that the dyestuffs, chemicals and textile auxiliaries vary from one day to another and even several times within a day. (Lin and Chen., 1997).

Textile wastewater presents the additional complexity of dealing with unknown quantities and varieties of dyes as well as low Biochemical Oxygen Demand (BOD)/Chemical Oxygen Demand (COD) ratio, which may affect the efficiency of the biological decolourization (Babu and Gubta., 2008). The treatment of textile wastewater is still a major environmental concern because of synthetic dyes which are difficult to remove by conventional treatment systems (Zhang et al; 2004).

Adsorption is an effective method of lowering the concentration of dissolved dyes in the effluent thus resulting in colour removal. The process of adsorption has an edge over other methods such as chemical oxidation, coagulation and reverse osmosis due to its sludge free clean operation and complete removal of dyes even from dilute solutions (Malik, 2003).These other means of dye removal are generally not feasible due to economic considerations (Tsai et al; 2001).

Continuous disposal of textile wastewater on land, which has limited capacity to assimilate the pollution load also leads to groundwater pollution. This study is focused on wastewater generation and disposal from local dyers in Maiduguri, Borno State, Nigeria. The study investigated the reduction of colour from textile wastewater subjected to activated carbon adsorption at different experimental conditions and to determine the optimum saturation time for colour removal on activated carbon adsorption process. The observation is restricted to the adsorption of colours from textile wastewater using granular activated carbon derived from rice husk and millet straw.

2. MATERIALS AND METHODS

Sampling Techniques

The textile wastewater sample used for this study was collected from one of the local dyers located at Shehuri South unit of Maiduguri metropolis, Borno State, Nigeria. The wastewater sample was collected in a plastic container and stored at room temperature prior to use for laboratory analysis. The storage condition minimized or inhibited chemical and microbial activities, thus limiting drastic changes in the wastewater characteristics.

The solid agricultural by-products used for this experimental work were Rice husk (RS), and Millet straw (MS).These solid by-products are readily available and were obtained from the local markets of Maiduguri metropolis.

Preparation of adsorbents

The low-cost adsorbents were grounded and sieved into particle size of 0.5mm which was carbonized at a temperature of 400^oC for 30mins. The char produced was impregnated with $ZnCl_2$ at a ratio of 1:2. The $Zncl_2$ was in pellets and dissolved in deionized water. Impregnated samples were placed in an oven and heated at 110 ^oC for 1hr after which samples were transferred to muffle furnance and activated at 500 ^oC for 1hr. Sample was washed with deionized water to ascertain neutrality. Activated carbon was dried and stored in an air tight container.

Characterization of Adsorbents

The activation performance of the produced adsorbent was investigated in two phases. In phase 1, the contact time was kept constant and the adsorbent dosage varied while in phase 2, adsorbent dosage was kept constant but contact time was varied. In each case, the true apparent colour removal performance was measured.

Prior to making all characterization analysis, a dilution factor of 1:10 was adopted. Thus 10ml of wastewater sample was diluted with 100ml of ionized water to enable clear readings.

The adsorption dosage varied from 5 to 35g in increment of 5g with a constant time of 2hrs, while the time varied from 1hr to 7hrs in increment of 1hr with constant adsorbent dosage of 10g. At each dosage and time variations, pH was measured to observe the dependence or otherwise of pH on the treated wastewater.

Experimental technique

Two treatments were involved in the study. There were two treatments for varying dosage with constant contact time for the two adsorbents. Similarly there were two treatments for varying contact time with constant dosage for the two adsorbents. Seven containers each for dosage and time for the two adsorbents were labeled as in Table 1a and b.

Table 1. Set up of Experiment for adsoption studies

Batch A : Contact Time = 2hrs.

S/No	1	2	3	4	5	6	7
Quantity (grams)	5	10	15	20	25	30	35

Note: Each container has the label of adsorbent

Batch B : Quantity = 10g .

S/No	1	2	3	4	5	6	7
Contact Time (hrs)	1	2	3	4	5	6	7

Note: Each container has the label of adsorbent.

The experimental work was conducted in batches with 50ml of raw wastewater sample placed in 7 different containers and diluted with 500ml of deionized water. It was then passed over the activated carbon and left for the desired time. Treated wastewater was passed through a filter paper to get a clear filtrate. Thereafter, colour, was measured for all conditions and two adsorbents.

Colour Analysis

A colorimeter (Hanna model) was used for the true colour measurement. It is a reagent free analysis. A negative value is read when the colour is beyond the machine range. In this study, sample was diluted and the dilution factor noted.

Diluted sample was placed in a 10ml container and inserted into the machine. In the control bottoms, a knob “Read” was pressed. The value of true colour appeared immediately and was recorded.

3. RESULTS AND DISCUSSION

The dyers manufacture cotton and polyester fabric. The production consists of desizing, dyeing and finishing. The local dyeing wastewaters are directly discharged to the land surface or into the nearest drainage systems and/or surface waters. The former with time goes into the groundwater through a simple diffusion process and via passive transport reach the groundwater thereby deteriorating the water quality to a great extent. The pollution leads to the release of unpleasant odour and creates a breeding ground for mosquitos due to the water concentration through blockage of drainage channels. In surface waters, it causes the depletion of oxygen.

The colour in the local textile wastewater is composed mainly of hydro sodium hydrosulfite (sodium Dithionite) NaHS in which the HS^- behave as a spherical anion. It is stable under most conditions and with low toxicity. NaHS is the common name for products containing sodium dithionite $Na_2S_2O_4$ as the active ingredient. The colour concentration in the untreated wastewater sample was 25570pt/co. The results obtained after the introduction of the textile wastewater to the adsorbents under the stated conditions are presented in Tables 2 and 3.

Table 2 Performance of Adsorbents at constant dosage (10g)

	Colour (pt/co)						
Contact time (hr)	1	2	3	4	5	6	7
Rice Husk (RH)	23500	19248	16650	13281	10800	9265	6250
Millet Straw (MS)	21700	15920	10070	8242	5581	2286	1410

Table 3 Performance of Adsorbents at 2 hours contact period

	Colour (pt/co)						
Dose (g)	5	10	15	20	25	30	35
Rice Husk (RH)	23600	18720	15250	11780	6520	3281	1416
MilletStraw(MS)	20600	16472	12470	10600	6200	2263	1058

Table 4 shows that the colour of the textile wastewater was reduced by 94.5 and 95.9% respectively for RH and MS at a contact time of 2hrs and with 35g of adsorbents. It was established that the color removal was increased with increase in adsorbent dose. The color removal was low initially because the active sites in the adsorbents could not be effectively utilized when the dosage was low. From fig 1 it may be deduced that an optimum adsorbent dosage at which maximum color was removed is 35g.

Table 4: Percentage removal of Colour from Textile wastewater with varying dosage of adsorbent Color Removal (%)

	Dosage of Adsorbent						
Adsorption	5	10	15	20	25	30	35
Rice Husk	7.7	26.8	40.36	53.93	74.50	87.2	94.5
Millet Straw	19.4	35.58	51.7	58.6	75.8	91.2	95.9

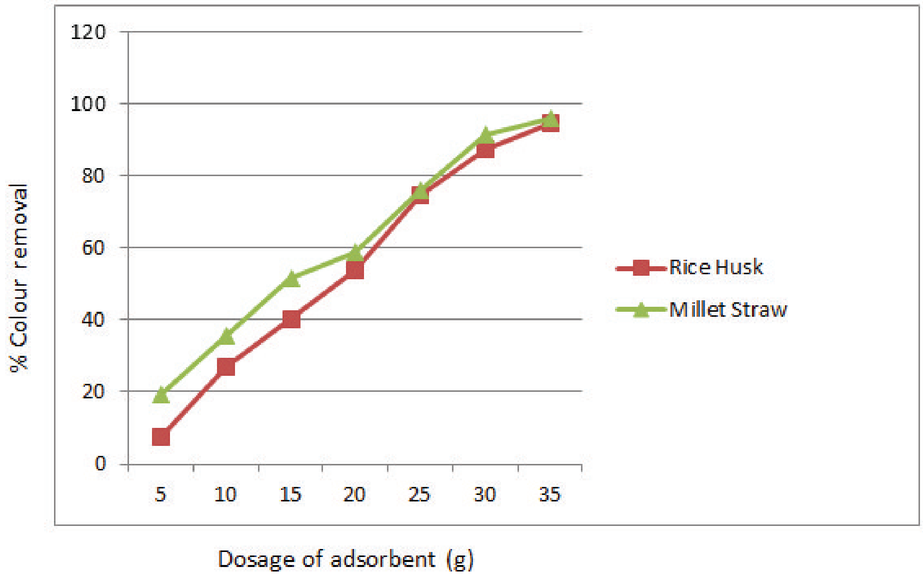

Fig.1 Colour removal (%) from textile wastewater at different dosage using Rice Husk and Millet Straw adsorbents

The effect of contact time on the adsorption of colour is presented in Table 5. Contact time is one of the most important factors in batch adsorption process. Results indicate that the adsorption rate for colour increased with increase in contact time. The rate of color removal was low at the initial stage probably due the larger surface area of the adsorbents not in full contact with the textile wastewater. As the contact time increase, colour removal increased due to larger surface area of adsorbents. As surface adsorption sites become exhausted, optimum removal was reached within 7hrs. In this study, adsorbents were added up to 10hrs with hourly increment but results revealed that there was no significant change in colour removal between 7 and 10hrs contact period. The optimal removal efficiency was reached at about 7hrs contact time and is an indicator that the adsorption phase has reached equilibrium. After 7hrs of contact, colour was reduced by 75.8% and 94.5% for rice husk and millet straw respectively.

Table 5: Percentage removal of Colour from textile wastewater with varying contact time.
COLOUR (%)

	Contact time (hrs)						
Adsorbent	1	2	3	4	5	6	7
Rice Husk	8.1	24.7	34.9	48.1	57.8	63.8	75.8
Millet Straw	15.1	37.7	60.6	67.8	78.8	91.1	94.5

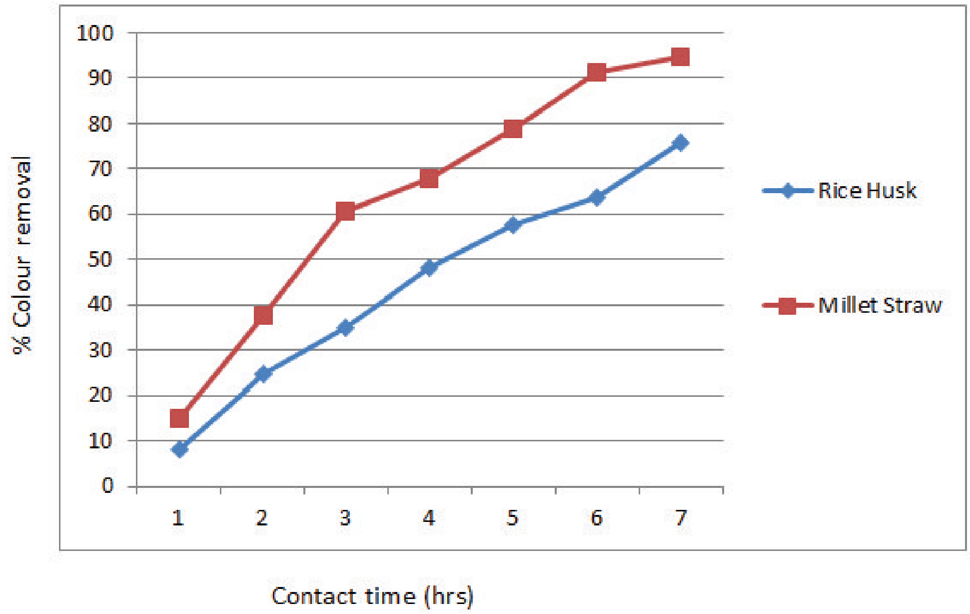

Fig. 2 Colour removal (%) from textile wastewater at different contact time using Rice Husk and millet straw adsorbents

4. Conclusion

The use of Rice Husk and Millet Straw adsorbents for colour removal in textile wastewater with dosage and constant time as variables showed an optimum dosage of 35g and optimum contact time of 7hrs. From the experiments with varying dosage, the maximum colour removal was 94.5% and 95.9% respectfully for RH, and MS at 35g dosage. Experiments with varying time indicate that maximum colour removal of 75.8% and 95.5% at 7hrs contact time for RH and MS respectively.

The results have shown that maximum adsorption capacity of the adsorbents in the order of colour removal with varying dosage is MS>RH while colour removal with varying time, follow the same pattern.

References

Babu B.V., and Gubta S.,(2008). Adsorbtion of Cr (VI) using activated carbon from neem leaves: Kinetic studies adsorbtion, 14:85-92.

Lin S. H. and Chen M.L., (1997). Treatment of textile wastewater by chemical method for re use. Water Res, 31:869-876.

Malik P.K., (2003).Use of activated carbon prepared from sawdust and rice-husk for adsorption of acid dyes: A case study of Acid yellow 36, Dyes and pigments, 56: 239-249.

Tsai W.T., Chang C.Y., Lin M.C., Chien S.F., Sun H.F.,and Hseih M.F.,(2001).Adsorption of acid dye on to activated carbon prepared from agricultural waste begasse by $Zncl_2$ activation. Chemosphere, 45(1): 51-58.

Zhang F.A., Yediler A., Liang X., and Kettrup A., (2004).Effects of dye additives on the ozonation process and oxidation by-products. A comparative study using hydrolyzed CI reactive red 120. Dyes and Pigments, 60:1-7.