EVALUATION OF MAIZE COB PEAT FOR DECOLORATION OF DYE WATERS

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ABSTRACT

The preparation of peat from maize cobs and its application in glass columns to remove colour from both synthetic dye solutions and textile factory effluents is reported. The capacity of the peat to remove colour and solids is demonstrated; the effect of the peat particle size on the decoloration and solid removal processes is evaluated and an economical mode of application for factory effluent treatment is suggested. With peat in the particle size range 500 - 150 μm, 90% of attainable colour and solids reduction can be realised.

INTRODUCTION

There has been a continuing need to clean up industrial effluents so as to reduce river pollution[1]. As environmental protection regulation becomes more rigid, the search for more economical and efficient matrices for effluent treatment has been intensified[2-9]. Colourant adsorption onto activated carbon, silica, Fuller's earth, bauxite, etc. has been investigated. The use of peat as an adsorbent has been reported[1,5,6,10,11]. Maize cob has been applied, both as is[12] and decayed[13,14], to remove dyes from dye solutions and textile effluents respectively. The present work seeks to produce some kind of peat from maize cobs and apply the peat to remove colourants from dye solutions and textile effluents; it was the basis of our earlier work[14] in which maize peat was presented as a component of a mixed matrix for textile effluent treatment.

EXPERIMENTAL

Apparatus
The spectral studies reported relied on a Corning 253 colorimeter. The performance of the maize cob peat was studied in glass columns (35.0cm x 1.0cm i.d.).

Dye samples
The experimental dyestuffs were anthraquinone acid blue (A) and methylene blue (M), both of Analar grade, obtained from BDH; they were used without further purification.

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Textile effluents
The textile effluents investigated in this study were scooped off the drains of their generating factories. Two factories were sampled and the samples obtained from different operation units of each factory were combined together in equal volumes to obtain a pooled effluent for each factory. They were letter-coded Pu and Ps.

Maize cobs
Maize cobs were collected from private farmers in Ahmadu Bello University. They were selected to exclude earth and rubbish.

Dye solutions
Each dye was made to contain 0.1 gl^{-1} (100 ppm) in one case and 2.8 gl^{-1} (2800 ppm) in another case in aqueous solution to simulate residual dye bath concentration and a highly concentrated dye solution respectively.

Production of peat
10 kg of the selected maize cobs was soaked in tap water in a 150 l plastic jar continuously ensuring complete immersion and left to stand for thirteen months. The cobs became so soft that they are easily broken by squeezing between the fingers. Then they were removed from the jar and washed with plenty of water to remove algae and any dust. The 'peat' now obtained was dried in sunshine for two weeks and packed.

Particle size separation
The dried peat was pounded with a wooden mortar and pestle to a consistency having a

range of particle sizes. This material was then sieved with a set of sieves (Endecott Model BS 410/1986) to obtain different fractions each having its particle size including 150, 250, 300, 355, 425, 500, 850 μm and 1.18, 1.40, 1.70 and 2.00 mm.

Removal of yellow humin

Each particle size fraction was soaked in surplus water and allowed to stand, stirring to strain the yellow humin out of the peat into the bulk of water. The washings were discarded by decantation while the washing and decanting process was continued until the washings no longer showed the yellow colour; this took six days. The washed peat fractions were air-dried and stored in stoppered plastic bottles until required.

Packing the column

The gravity-flow columns used to evaluate the performance of peat were packed with a slurry of a weighed amount of the respective peat fractions rendered in distilled water using a plug of glass wool to rest the bed. Each column was initially flushed with distilled water to remove traces of yellow humin before applying any test sample.

Characterization of the samples

Both the dye solutions and textile effluents used as samples in this work were initially characterised by determining the wavelength of maximum absorption, λ_{max}, of each sample using the colorimeter and scanning the absorption of each sample in the 400 - 700 nm range. The λ_{max} values are presented in Table 1.

Decoloration test

To investigate whether the peat removes colour from either a dye solution or factory effluent, 15.0 cm^3 of each dye solution or effluent was mixed with 1.0 g of a treated peat fraction in a test tube. The tube was then clamped onto a mechanical shaker (Gallenkamp) and agitated at medium speed for six hours. The tube was allowed to stand for 45 minutes for its content to settle. The supernatant was then decanted and its absorbance measured at the respective λ_{max} against the untreated sample. The results are presented in Table 1 for the 150 μm particle size fraction.

Effluent treatment

To explore the potential of the peat for textile effluent treatment, columns were packed as described earlier using 4.0 g of treated peat fractions. Then 40.0 cm^3 of an effluent was loaded onto a column and made to flow through it under gravity at a rate of 0.5 cm^3 min^{-1}. The absorbance, A, of the eluate collected at the bottom of the column was measured at the respective λ_{max}; each of the dye solutions was similarly observed. The results are presented in Table 2 for the 150 μm particle size peat fraction. Also the solid content of each effluent was determined by evaporating 20.0 cm^3 of the effluent to dryness over a steam bath in a preweighed evaporating basin and determining the residue mass by difference; this determination was conducted in triplicate for both the raw effluent and after treatment in columns as described in this section. The results are also presented in Table 2 for the 150 μm particle size peat fraction.

Particle size effect

The effluent treatment procedure just described was repeated on columns packed with each of the particle size fractions listed earlier and the effluent absorbances, after treatment, compared with that of the untreated samples for various particle sizes. The results are presented as

Table 1: Spectral characterization of colourants and decoloration test.

Sample	λ_{max} (nm)	A		% colour removal
		untreated	treated	
A	620	0.42	0.006	98.6
M	600	0.46	0.02	95.7
Pu	620	0.47	0.25	46.8
Ps	590	0.34	0.18	47.1

Table 2: Improvements by sample treatment

Sample	A at λ_{max}		Residue mass (g)		Colour reduction (%)	Solids reduction (%)
	Untreated	Treated	Untreated	Treated		
A	0.42	0.005	0.043	0.004	98.8	90.7
M	0.46	0.01	0.054	0.004	97.8	92.6
Pu	0.47	0.20	0.052	0.040	57.4	23.1
Ps	0.34	0.20	0.033	0.029	41.2	13.0

averages of triplicate observations in Table 3 for all four samples. The solid content of the effluents Pu and Ps was determined again, after treatment with peat of the different particle sizes and compared with that of the untreated sample; the results are included in Table 3 as averages of triplicate determinations.

RESULTS AND DISCUSSION

Spectral characteristics and decoloration test

The λ_{max} values reported in Table 1 for the dye solutions were obtained for the 100 ppm solutions. Each pooled effluent also exhibited only one band with λ_{max} as recorded. It is

Table 3: Performance of different particle size fractions of peat

Particle size (μm)	% Colour reduction				% solids reduction	
	A	M	Pu	Ps	Pu	Ps
150	96.3	99.8	46.6	47.1	22.3	12.6
250	94.7	99.2	41.9	42.7	20.7	12.0
300	93.1	99.0	40.2	33.8	17.3	11.9
355	92.9	98.0	40.0	32.9	14.2	11.0
425	92.1	97.4	38.5	32.4	12.0	11.0
500	90.6	97.0	33.3	29.4	10.3	11.0
850	84.6	96.2	29.0	25.0	8.8	9.2
1180	74.6	94.2	24.7	22.5	7.9	8.7
1400	73.5	92.8	18.3	17.4	5.9	6.0
1700	65.7	90.8	14.0	4.7	5.0	4.5
2000	54.0	89.0	6.5	3.0	3.9	4.0

suggested here that either each effluent contained one chromogen only or all the chromogens present had bands which overlapped at the same spectral region; the latter was confirmed by thin layer chromatography, which indicated three components - a yellow, green and white - in both effluents. The dyestuffs were spectrally pure compounds and hence exhibited one band only in the visible. The changes in absorbance following the decoloration test confirm that the peat matrix does remove colour from the samples. While the anthraquinone acid blue was 98.6% removed, the methylene blue was 95.7% removed from 15cm^3 of their 100 ppm solutions by one gram of the 150 μm peat fraction.

The colour of 15.0 cm^3 of pooled effluent was 46.8% or 47.1% removed by 1.0 g of the 150 μm peat matrix. The results of Table 2 indicate similar colour reductions for all samples. A drastic reduction in the solid content of samples is also indicated in this table. Similar trends to those reported in Tables 1 and 2 were observed when peat matrices of other particle sizes were investigated.

Effluent treatment and particle size effect

The results of Table 3 show that the peat removes both colourants and solid matter; the smallest particle size investigated yielded the best results. The trend in both colour reduction and solids reduction recommends the selection of smaller particle sizes against larger ones. Peat rendered in a particle size of 150 μm was better than fractions of larger particle sizes. Difficulty was encountered in maintaining eluent flow through the column when particle sizes below 150 μm were deployed. For practical efficiency, particle sizes in the range 500 - 150 μm are recommended for gravity-flow columns; then up to 90% of attainable effluent improvement can be achieved. Particle sizes above 500 μm were not effective for either colour removal or solids reduction; with these, less than 90% of attainable effluent improvement can be realised.

CONCLUSION

The maize peat presented in this article has a capacity to absorb colourants out of dye solutions and textile effluents. A capacity to also reduce the solid content of effluents is demonstrated. An all-round quality improvement can be realised by applying this peat, at a particle size range of 500 - 150 μm, to treat textile effluents.

REFERENCES

1. Mckay, G., Jour. Soc. Dyers and Colourists, 1978, 9(8), 357.
2. Poots, V.J.P., Mckay, G. and Healy, J.J., Jour. Wat. Res., 1976, 10, 1061.
3. Haith, D.A., Environmental System Optimization, pp 1-8, John Wiley and Sons Inc., New York, 1982.
4. Culp, L.G. and Culp, L.R., New Concepts in Water Purification, pp 6-11, Van Nostrand Reinhold Company, New York, 1974.
5. Ottermeyer, W., Wat. Poll. Res., 1930, 3(8), 272.
6. Allen, S.J. and Mckay, K.Y.H., Chem. Abstr. 1978, 108, 175945 h.
7. Chancy, R.L., Jour. Wat. Poll. Contr. Fed., 1979, 51(1), 17.
8. Ekanem, E.J., Nig. Jour. Chem. Res., 1996, 1, 61.
9. Ekanem, E.J., Nig. Jour. Chem. Res., 1996, 1, 13.
10. Smith, E.F., MacCarthy, P., Yu, T.C. and Mark (Jnr), H.B., In Rubin, A.J. (ed.), Chemistry of Waste water Technology, pp. 349-371, Ann Arbor Science Publishers, Ann Arbor, Michigan 48106, 1978.

11. Poots, V.K.P., Mckay, G. and Healy, J.J., Chem. Abstr., 1978, 89, 151974j.

12. El-Geundi, M. and Aly, I., Adsorption Sci. Technol., 1994, 9(3), 121.

13. Ibrahim, M.B., M.Sc. Thesis, Bayero University, Kano, 1995.

14. Isuaikoh, M.O., Bakalyil, A., Ibrahim, M.B. and Ekanem, E.J., Nig. Jour. Chem. Res., 1998, 3, 9.

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