APPLICATION OF ANIMAL DUNG FOR DECOLORISING TEXTILE EFFLUENTS

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ABSTRACT

The application of cowdung for removing residual colours from textile effluents is reported. The cowdung was most decolorising when crushed, slightly moistened and undecomposed. 5.0g of dry dung possessed a void volume of 19.2cm^3, the dung showed a uv-absorption that overlapped the absorption band of the effluent investigated and was leached free of the absorption before the effluent was applied to it. Estimated in various ways, the efficiency of effluent decoloration was commendable: 5.0g dung got spent after receiving six 20.0cm^3 fractions of the test effluent for a total influent volume of 120cm^3; the same mass of dung was saturated when the same 20.0cm^3 effluent fraction was recycled six times through it; in the continued presence of fresh dung, 50.0cm^3 of the test effluent was rendered colourless by five 5.0g dung columns for a total of 25.0g dung. An attempt to regenerate the spent cowdung failed but indicated that colour removal was achieved by a combination of adsorptive and molecular sieving processes.

INTRODUCTION

Public health and environmental protection continue to focus attention on the quality of effluents discharged from industries. The intesely coloured fluids that fill the drainage systems in the immediate vicinity of textile industries, particularly in Nigeria, silently indict those industries for polluting the terrain and waterways in which their effluents pass. More efficient methods for treating these effluents are needed to satisfy the demands of environmental protection legislation. Effluent and wastewater treatment have relied on methods that cause the alteration of pollutants or sieve them out of the waters before their disposal[1-4]. While microbial activity[2,5,6,7] and chemical oxidants like ozone and bromine chloride[1,2] have been applied to induce the alteration of pollutant molecules, activated carbon[2,3,4,8], peat[9] and synthetic resins[2] have been applied to physically sieve pollutant molecules and their decomposition products out of effluents and wastewaters.

In this article, the aplication of cowdung as a matrix for achieving the removal of colourants from textile effluents is described. This application has the advantage of simplicity and low cost because cowdung is inexpensive, occurring naturally in a form ready for use. In this country, cowdung is more abundant in the northern region where the cattle Fulani herdsmen are concentrated. It is also in this region that most of the textile industries, including the small cottage ones, are located. To maintain the cost benefits and permit the option of still applying the used dung in its traditional agricultural use in soil conditioning, the dung was investigated without modification.

EXPERIMENTAL

The textile effluents

The Textile effluents observed in this work were collected off the drain of their generating factories including Arewa Textiles Limited (ATL), Kaduna Textiles Limited (KTL), both located in Kaduna city of Nigeria, and the dyeing laboratory of the Department of Textile Science and Technology of Ahmadu Bello University (ABU), Zaria. While the effluents collected off the public companies were clear solutions, that of the ABU Textile Science Department was a dark blue suspension out of which a sediment separated on standing.

The animal dung

The animal dungs were collected from the dung yard and pens of the Faculty of Veterinary Medicine, Ahmadu Bello University, Zaria and from a private farm in Zaria. The dungs of horse, cow, goat, sheep, rabbit and pig were observed in the initial exploratory step of the work.

Instruments

The apparatus included open milk cans perforated at the bottom, cylindrical glass columns (1.7cm x 46.0cm), a Corning colorimeter and a Unicam SP

800 uv-visible spectrophotometer.

Exploratory observations

Each effluent was appropriately diluted and scanned under uv-visible to identify their wavelengths of maximum absorption (λ_{max}). Each dung was dried to a brown colour and most of them had a fine fibrous texture. A sample (5.0g) was taken in a milk can and exposed to a pre- decided set of conditions. 10.0cm^3 of the same effluent was applied to flush 1g of each dung sample and the absorbance at λ_{max} of the runoff compared with that of the untreated effluent. On the basis of these observations and other considerations highlighted later, cowdung was selected for detailed investigation as reported hereunder.

Conditioning the cowdung

The cowdung was spread to dry in air; it was crushed with a mortar and pestle and preserved in the cupboard for use as required, preserving some of it uncrushed for observation in that form. The crushed dung was disposed in 5.0g fractions in the perforated cans and exposed to different conditions of moisture, warmth, light and air supply. The samples were left in positions corresponding to these conditions for varying durations to achieve varying degrees of ageing. 1.0g of each sample was then applied to investigate 10cm^3 of the same effluent as was done in the initial exploration reported earlier. The effects of those parameters investigated which proved significant are presented in Table 1.

Table 1: Optimization of dung conditions.

Texture	Added moisture	Duration before use (days)	A (units)
Uncrushsed	Zero	0 - 7	0.60
Fine	Zero	0 - 7	0.60
Fine	Low	0 - 3	0.15
Fine	Medium	0 - 3	0.20
Fine	High	0 - 3	0.30
Uncrushed	Low	0 - 3	0.45
Fine	Low	7	0.35
Fine	Medium	7	0.37
Fine	High	7	0.38

Table 2: The void volume in 5g of cowdung

-Effluent volume passed (cm^3)	Runoff volume collected (cm^3)	Void volume (cm^3)
15.0	0.0	-
20.0	0.8	19.2
25.0	5.6	19.4
30.0	10.8	19.2

Further characterisation of cowdung

5.0g portions of the dry dung were packed into the glass columns using glass wool as support. The properties of the dung that relate to its application as decolorant for the effluents were derived from these portions.

In an attempt to determine the void volume in 5.0g of the dung, the column was flushed with distilled water until all air bubbles were displaced. The column was then run dry and immediately flushed in sequence with 15.0, 20.0, 25.0 and 30.0cm^3 portions of the ABU Textile Science effluent, running the column dry and measuring the runoff from each portion. The results are presented in Table 2.

To remove intrinsic absorption at λ_{max} from the dung, it was flushed with distilled water until the effluent liquid became clear to the eye and yielded zero absorbance at λ_{max}. The progress of the leaching is presented in Table 3 as diminishing absorption peak heights of the effluent measured at intervals during the leaching.

Table 3: Leaching of the cowdung

Cummulative water volume passed (cm^3)	Peak height of washing (chart divisions)
20	35
40	[illegible]
80	8
120	[illegible]

Table 4: Decoloring efficiency of the dung - same column flushed with fresh effluent fractions.

Effluent fraction number	Cumulative infflluent volume (cm^3)	Peak height of runoff (chart divisions)
1	20	34.5
2	40	33.0
3	60	27.0
4	80	18.0
5	100	11.0
6*	120	9.0
7	140	9.0

* point at which column charge got spent.

For the determination of the decoloration efficiency of the cowdung, nine columns were applied. Seven $20cm^3$ fractions of the ABU Textile Science effluent were applied in a sequence to the same 5.0g column and the peak height at λ_{max} measured for the runoff collected from each fraction; the results are shown in Table 4. The same parameter was determined in a different way by passing a $20cm^3$ effluent fraction and successive runoffs from it repeatedly through the same column, reserving a sample each time for measuring the absorption peak height at λ_{max} as before. The progressive decoloration is indicated in

Table 5: Decoloring efficiency of the dung - same column flushed repeatedly with the same effluent fraction.

Flushing cycle number	1	2	3	4	5	6*	7
Peak height of runoff (chart divisions)	37.0	35.0	18.0	15.0	10.0	8.0	8.0

* Point at which column charge got spent.

Table 6: Decoloring efficiency of the dung - cascade of columns flushed with the same effluent fraction.

Column number	1	2	3	4	5	6	7
Peak height of runoff (chart divisions)	54.0	53.0	42.0	25.0	0.0	0.0	0.0

Table 5. Further investigating the decoloration of the effluent by the dung, $50cm^3$ of the ABU effluent was passed through a cascade of seven columns, reserving samples between columns to run their uv-visible scans; the attenuation in peak height shown in Table 6 indicates the progress of decoloration. Similar trials were conducted for both the ATL and KTL effluents and are discussed later (Fig. 1).

It was investigated whether a column used to saturation could be regenerated by washing in water and drying in the oven at a temperature of 120°C for five hours. The columns were packed again as before using the washed and dried dung and the effluent passed through them in the same routine as before. The results obtained on the reused columns are presented in Table 7.

Table 7a: Reuse of spent dung - same column flushed with fresh effluent fractions.

Effluent fraction number	Cumulative effluent volume (cm^3)	Peak height of runoff (chart divisions)
1	20	11.0
2	40	19.0
3	60	29.0
4	80	30.5
5	100	31.0
6	120	32.0
7	140	32.0

Table 7b: Reuse of spent dung - same column flushed repeatedly with the same effluent fraction.

Flushing cycle number	Peak height of runoff (chart divisions)
1	7.0
2	24.0
3	27.0
4	29.0
5	30.0
6	30.0
7	30.0

Table 7c: Reuse of spent dung - Cascade of columns flushed with the same $50cm^3$ effluent fraction

Column number	Peak height of runoff (chart divisions)
1	17.0
2	26.0
3	32.0
4	33.0
5	33.0
6	34.0
7	34.0

RESULTS AND DISCUSSION

Selection of effluent

All the effluents investigated behaved in a similar manner when they were passed through the animal dung columns. The dung always yielded an attenuation in colour intensity either to the eye or as photometrically indicated by the decreasing absorbances measured at λ_{max}. The ABU Textile Science effluent had a more complex constitution than the others and was selected to illustrate the observations made; it more strongly supported the arguments of this article which, however, apply broadly to all the effluents that were observed. The different effluents had variant λ_{max} values; the ABU Textile Science effluent had λ_{max} values at 350nm and 616nm. Also the dungs of various farm animals observed yielded broadly similar results.

Selection of the dung

Generally when the effluent was passed through a dung sample, a decrease in colour intensity and shade was visually observed and absorbance values measured at λ_{max} for successive runoffs were progressively lower compared to that of the untreated effluent. In anticipation of the large bulk of dung that may be required in the field application of the findings of this work and the fact that cowdung is much more abundant than others in this country, cowdung was selected for illustrating the results of this investigation. When a mixed or other dung was applied, the same general results were obtained although the specific parameters of the matrix were different.

Conditioning of the dung

To obtain variation in the supply of warmth, light and air to dung samples in the process of ageing, batches of samples were placed on a window sill inside and a window sill outside the laboratory, a closed cupboard in the laboratory and a shady ground in the garden. When applied to the effluent, dung samples maintained at all four locations for the same duration yielded effluent runoffs with the same absorbance values at λ_{max}. These parameters were not significant in the investigation and all results reported relate to samples located on the laboaratory window indoors. The parameters that were significant in conditioning the cowdung are reflected in Table 1. The dung needed to be crushed to loosen its texture and redistribute the pore sizes in the matrix. The overall optimum conditions yielded only a slight decoloration in the uncrushed dung; the crushing produced maximum decoloration (minimum runoff absorbance). The moisture was crucial for the decoloration: the colour remained unchanged when the effluent was applied to the dry dung even when it was properly crushed. A low moisture level always yielded the maximum effluent decoloration. This was probably the condition in which the texture of the dung maintained optimum pore sizes and pore distribution in the entire matrix. The moisture probably aided a rearrangement of the dung particles. The ageing of the dung did not offer any advantage; it actually reduced the effectiveness of the dung. Up to three days of ageing did not influence the results but up to seven days ageing reduced the decoloring effectiveness. For maximum decoloration it is recommended that the dung be applied crushed, optimally moistened and without ageing.

The void volume

The free space in 5.0g of the cowdung in its optimised condition averaged $19.27cm^3$ from the results presented in Table 2. This is the space between the particles of the matrix that supports the surface dependent activities involved in molecular adsorption and desorption on the cowdung. It is indicated by the volume that is trapped up in the dung and only influent volume in excess of this can be collected again as runoff. This large value must contribute to the observed high efficiency of colour removal and is of practical importance.

The intrinsic absorption

The data of Table 3 confirmed that the cowdung contained material that showed uv- absorption at the λmax of the effluent; this material may be leached out and was usually leached out before applying the effluent to any column. The results presented in Table 3 indicatae that the uv- absorptive substance intrinsic in the dung may be removed by leaching 5.0g of dung with up to $120cm^3$ of water. This investigation gives merit to washing the dung and drying to low moisture level before applying the effluent.

Decoloration efficiency

The decoloring efficiency of the dung is indicated differently in Tables 4, 5 and 6. The peak height decreases steadily to a flat profile; in Table 4 the dung gets spent after passing six effluent fractions for a total influent volume of $120cm^3$, while in Table 5 it gets spent after the same effluent fraction has been recycled six times through the column; it is removal occurs by a combination of adsorptive and molecular sieving processes. After the adsorption sites on the dung get saturated, the dyes continue to be removed from the influent by the sieving action that scrubs the runoff down to a steady peak height. The peak gets entirely removed if fresh charge of dung is sufficient. This is demonstrated in Fig. 1 for $50.0cm^3$ ATL effluent before and after passing through 25.0g cowdung. The result for the KTL effluent was similar.

Attempt at regeneration of spent dung

Although the attempt to regenerate the spent dung proved unsuccessful as presented in Table 7, these results presented additional basis for speculating on the mechanism by which the colour removal proceeds. The peak height of the runoffs increased in all cases indicating that the spent dung actually adds more colour to any influent fluid. It is expected that

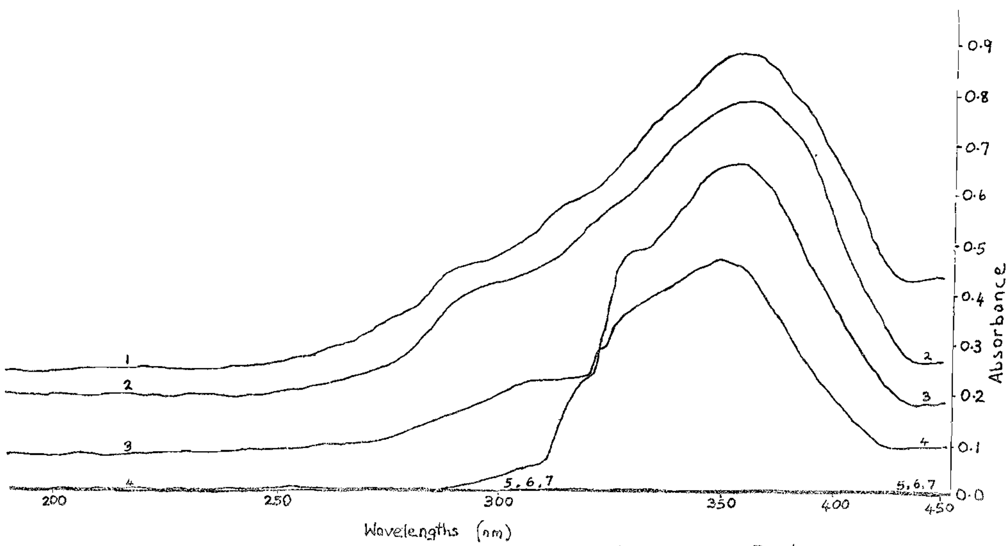

Fig. 1 – Uv- spectral trace of ATL effluent after passing through 1–7 columns.

remarkable that in Table 6 where the influent volume continues to encounter fresh dung the whole way along, the effluent is scrubbed entirely free of colour. $50.0cm^3$ of effluent is rendered colourless by the time it has passed through five 5.0g columns: this is the basis for recommending this matrix for colour removal. It would offer an advantage over a matrix like carbon which always leaves a residual colour in the treated effluent. The peak height profile implied in Tables 4-6 suggests that the colour

any colourant trapped loosely on the dung by sieving action was removed again in the washing step of the attempt to regenerate the dung. At least some desorption of the colourant from the dung matrix back into the effluent runoff also occurs and may, in-fact, be significant. It is expected that some modification of the matrix may render it amenable to regeneration and this is being researched.

CONCLUSION

Cowdung, even without modification, has the capacity to remove colours from textile effluents. It is cheap and simple to apply. Its traditional role in soil conditioning for agriculture may still be maintained.

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