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Application of natural dye extract from the bark of a plant *Rhizophora recemosa*

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ABSTRACT

The bark of the plant *Rhizophora recemosa* was collected, chopped, dried, pulverized and the dye content was extracted using water and ethanol absolute as solvents. The percentage yields of the dyestuffs, melting point, R_f value and Uv/visible absorptions of the dye extract were determined. The dyestuff got was used to colour petroleum jelly, food (pap) and drink (illicit gin). The dye bath prepared with the dye was also used to dye some textile fabrics, mordanted and unmordanted types. The final products from these dyeings showed varied colour shades and hues. Their wash and light fastness properties did improve with mordanting.

Key words: Natural dyestuffs, *Rhizophora recemosa*, solvent extraction, fabric dyeings and substrates colouring.

INTRODUCTION

Dyes are substances which impart colours to materials such as cosmetics foods, drugs, hairs, furs and polymers[1]. Dye could be natural or of synthetic origin. All dyes were basically natural, extracted from some plants and animals until the middle of 19th century. The roots, stems, leaves, flowers and fruits of various plants supplied vegetable dyes. Certain mollusks found on the shores of the Mediterranean sea supplied animal dye as the famous tyrian purple[2].

The sourcing and processing of natural dyes do pose some problems. Many of these natural dyes have poor affinity for textile materials unless such materials are treated with mordants which are salts of Al, Fe, Cr and Sn. The sourcing of natural dyes for mass consumption requires several hectares of the world's agricultural land. Also, the raffinates or wastes from the dye extractions and the exhaust liquors from dyeings, all require proper handling and disposal to check pollution[3-5].

The return to the use of natural dyes in recent times has been based on the fact that they can exhibit better biodegradability and generally have higher compatibility with the environment compared to the synthetic dyes[6-7]. Nigeria has abundant resources in terms of plants which contain dyes in parts such as the roots, barks, leaves, seeds, fruits and flowers. Most of these plants have medicinal and dye potentials[8-10].

Rhizophora recemosa is a mangrove tree and the largest of the *Rhizophoras*. It colonizes the muddy vegetation between high and low tide. It extends from the Senegal river to Angola, the east coast of tropical America and neighbouring islands. In Nigeria, they are found in the south-south region along the Niger-Delta rivers. They habit the borders of rivers, estuaries and lagoons. The tree grow up to 40m high and 2.5m in girth in favourable conditions, but often forms shrubby tangles up to 10m high with stilt-root and slender aerial roots hanging down from high up[8]. The leaves are 5 – 15 cm by 2.5 – 6.0 cm broad tapering to the bluntly

pointed apex, narrowly cuneate. It flowers between August-December with greenish sepals usually under 12 mm long, greenish-white hairy petals, its stalk is 2-5 mm long. The root from the apex reaches 30-60 cm long and 12 mm diameter. The wood is reddish, very hard, brittle and gummy.

This present research work intends to extract the dyestuff from the bark of *Rhizophora recemosa* and utilize the dye extract to colour local gin (ogogoro), pap (akamu) petroleum jelly, textile fabrics and evaluate the colour, dye potential and the fastness properties of the dyed fabrics.

EXPERIMENTAL

Materials

The plant *Rhizophora recemosa* used for this work was got from Ugbodede, Warri, Delta State, Nigeria. The UV/visible spectrophotometer used was obtained from the Petroleum Training Institute (PTI), Effurun, Warri, Delta State, Nigeria. Soxhlet extractor, tin-layer chromatographic plates and BDH chemicals were used for this work. The textile fabric, illicit gin (ogogoro), petroleum jelly and pap (akamu) used for this work were purchased from Abraka market, Delta State, Nigeria.

Methods

Solvent extraction

The bark of *Rhizophora recemosa* was collected, dried, chopped into tiny pieces and pulverized to fine particle sizes for most intimate contact with solvent[11]. Known weights of the pulverized samples were fed into soxhlet extractor using water and ethanol absolute as the solvents separately. The mixture of solvent-sample was refluxed for 3h in each case. The extract phases were then distilled to recover part of the solvent and finally evaporated to dryness to obtain dried solid dye samples. The percentage yields, pH value, melting point, colour and solubilities of the dye were determined.

Thin-layer chromatography (TLC)

TLC was used to purify and separate the plant extracts into the different colour spots on the chromatoplate. The chromatograms were developed on a microscope slide [12]. These were dried and observed visually for their different colours. The solvents used for eluting the samples were toluene: ethanol (1:1).

UV/Visible spectrophotometry

The UV/Visible spectra of the dye specimen was recorded using HEX10SaUV/visible spectrophotometer V 4.20 machine. The absorption peaks (lmax) at different absorbances were recorded using ethanol as solvent for the preparation of the dye solution.

Dyeing of textile fabrics

Preparation of the dye solution

Here, 1.0g of the dry dye sample was measured into two separate beakers. Little amount of water was added to make paste form of the dye sample. It was then washed into 500mL flat-bottom flask with water at about 60°C to bring the volume to 100mL dye solution. The solution was boiled for about 5min. to aid good dissolution of the dye and then cooled.

Preparation of the dye bath

Here, 2% depth of colour was required to be imparted to the textile fabric (wool) used. Therefore, 25mL of the dye solution was put into a bath and diluted to 100ml solution. For a liquor ratio of 50:1, 2.0g of scoured wool material was introduced into the dye bath and dyed for 30min. at about 60°C. The material was removed and allowed to cool. It was then rinsed with cold water to remove loose dye particles adhering to the fabric surfaces. The cotton material was then air dried and tested for fastness properties. Also, mordanting of some of the wool materials was done by introducing the scoured wool fabrics into 2% solutions of potassium dichromate, alum and stannous chloride respectively, they were warmed for about 30min. at about 60°C. They were then dyed in the dye bath to compare colour shades, hues and fastness properties with the unmordanted fabric.

Fastness properties of dyed fabrics

light fastness

One set of the dyed wool fabrics were exposed to sunlight for a period of about a week while the other set were kept in the dark wrapped in black polythene bags. The exposed ones were rated to the unexposed fabrics on a grey scale[13-15]. This was done in the absence of the American

Association of Textile Chemists and Colourists (AATCC) standards.

Wash fastness

Again, one set of the dyed fabrics were washed with mild soap (canoe) solutions, another set with stronger detergent (Omo) solutions at 60°C for 30min. in a Lini test wash wheel machine in accordance with ISO washing test No 3. The washed fabrics were compared with the unwashed fabrics using grey scale[10,14-16].

Cosmetics (Petroleum Jelly) Colouring

100.0g of petroleum jelly was melted and 2.0g of dry dye sample dissolved in butylalcohol was mixed with the jelly in a glass beaker. The mixture was heated with the addition of small quantity of potassium laurate as surfactant at about 60°C. The mixture was then cooled to obtain a uniformly dispersed dye molecules in the jelly.

Food (Pap) Colouring

100.0g of pap (akamu) was first dissolved in water. Then 2.0g dry dye sample was measured into a glass beaker, water was added to make about 200ml dye solution at about 60°C with continuous stirring. The hot dye solution was heated to boil. The boiling dye solution was poured into the pap solution in a cooking pot and stirred vigorously until a uniform semi-solid pap meal was obtained.

Alcoholic drink (Illicit gin) colouring

2.0g of the dry dye sample was mixed with 100ml of illicit gin (Ogogoro) in a glass bottle. The bottle was corked and shaken vigorously for about 10min. A homogenous mixture was formed with fine colour shade.

RESULTS AND DISCUSSION

The dye sample from the bark of *Rhizophora recemosa* plant was found to be soluble in water and organic solvents. It gave yields of 8.50% and 5.20% in ethanol and water as extracting solvents respectively, the difference in yields may be due to lower solubility of the dye in water. Also the pH value of the aqueous slurry was 6.50, the yellowish red colour of the dye melted in the range, 90-95°C (Table 1). The yields, although poor were of significant amount for dye exploitation[15,17].

In Table 2, the chromatogram developed using toluene and ethanol (1:1) as eluting solvents gave reddish spot with R_f of 0.73 for the dye sample from the *Rhizophora recemosa* bark. The absorption peaks of the dye sample showed evidence of non-colouring matters which absorbed UV/visible light below 400nm (Table 3). These materials may be impurities associated with the dye extracts after the basic purification process using chromatographic techniques[11,15]. The absorption of the dye sample at

Table 1: Some properties of the dye extracts

Plant Material	Ground sample (g)	Dye extract (g)	Yield* (%)	pH	Mpt (°C)	colour (Visual)	Solubility	
							Cold Water	Hot Water
Rhizophora recemosa (bark)	10.00	0.85_E 0.52_W	8.50_E 5.20_W	6.50	90-95	Yellowish red	soluble	Readily soluble

*Dye extract and yield, the subscripts E and W denote ethanol and water as extracting solvents respectively

Table 2: Evaluation of Chromatograms

Dye sample	Distance moved by solvent front (cm)	Distance moved by solute (cm)	R_f value
Rhizophora recemosa (bark)	5.52	4.00	0.72

Table 3: UV/visible spectral analysis

Dye sample	UV/visible absorptions*		Structure assignment
	Absorbance	λmax (nm)	
Rhizophora recemosa (bark)	4.432	196	non-colouring matter
	4.721	298	non-colouring matter
	6.000	434	colouring matter

* uv/visible absorptions of dye samples in ethanol solvent.

Table 4: Colour shades/hues and fastness properties of the dyed textile fabrics

Rhizophora recemosa (bark)	**Fabric colour**	**Light fastness**	**Wash Fastness**	
	(Wool)	**(Grey scale)**	**Soap (Canoe)**	**detergent (omo)**
Unmordanted fabric	Yellowish red	2-3	2-3	1-2
Potassium dichromate mordant	Brownish red	3-4	3-4	2-3
Alum mordant	Reddish brown	2-3	2-3	2-3
Stannous chloride mordant	Yellowish brown	2-3	2-3	2-3

1-2 – most colour change
2-3 – colour change
3-4 – slight colour change
4-5 – colour retained

Table 5: Colour imparted on substrates

Dye sample and substrates	Colour imparted
Rhizophora recemosa (bark)	
Pap (akamu)	light yellowish red
Illicit gin (ogogoro)	brownish red
Petroleum jelly	Light reddish brown

434 nm was consistent with the yellowish red colour of the dye[6,15].

In Table 4, the dyed fabrics showed varied colour shades when mordanted with salts of Cr, Al and Sn. They generally showed poor light and wash fastness properties which worsened with the unmordanted fabric. Natural dyes are known to possess poor fastness to light and wash as compared to synthetic dyes[10,15-17]. Potassium dichromate mordant appeared to impart superior fastness properties compared to the other mordants used. In Table 5, was the dye was used to impart colour on petroleum jelly, pap (akamu) and illicit gin (Ogogoro). The harmless nature of natural dyes could allow for these applications[4,18].

CONCLUSION

This research work has achieved some level of success in the use of a local material for dye and colouring applications in textiles, cosmetics, foods and drinks. Although the use of mordants in textile application is found to be essential to

improving colour shades and fastness properties of the dyes. Therefore the harmless nature of natural dyes informs their use in the colouration of cosmetics, foods and drinks. This research efforts should be encouraged by Government in order to enhance raw materials development and gross domestic products of our nation.

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