DYESTUFF UTILIZATION OF THE BARK OF *PARKIA BIGLOBOSA* GROWN IN ANKPA, KOGI, NIGERIA

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Abstract: The use of natural dyes has in recent times gained the attention of scholars due to the assertion that they are ecofriendly, non - toxic, biodegradable and compatible with the environment as compared to synthetic dyes. As a result, this paper involved extracting dye from the bark of *Parkia biglobosa* which was used to dye cotton fabrics, either directly or alongside mordants and also applied on substrates. The extract imparted excellent and varied color shades on fabrics across the mordanting methods with potassium dichromate ($K_2Cr_2O_7$) mordant displaying superiority of fixation over the rest mordants and post mordanting method producing good depth of shade with better fastness properties on substrates. The crude plant extract also imparted pinkish brown, light pink and ox – blood color on food, cosmetics and alcoholic drink respectively. Based on the findings of this research, this plant is recommended as suitable replacement for some synthetic dyes in that it is less allergic, non toxic, biodegradable and environmentally compatible.
Keywords: Coloration, dye, extraction, mordants, *Parkia biglobosa*,.

Introduction

A substance is called a dye only if it has a suitable color, capable of being fixed to a fabric directly or with the help of a mordant and it must not be fugitive when fixed [1]. Dyes are colored substances capable of coloring fabrics in such a manner that the color cannot be removed by rubbing or washing. Dyes are also considered as substances that impart more or permanent color to a substrate like cosmetics, food, rubber, plastic, hairs etc. It is generally applied in an aqueous solution and may require mordants to improve their fastness on the fiber [2].

Before the Advent of synthetic dyes in 1856, natural products have been the source of dyes in use. Certain mollusk found on the shores of the Mediterranean Sea supplied animal dye as the famous tyrian purple [3]. Natural dyes are from plant roots, berries, bark, leaves, seed, wood and organic sources like fungi and lichens [4]. Natural dyes have great application as any variation in the concentration of the dye, mordants, type of water, soil and climate gives variation in color [5]. At a point, the coming of synthetic dyes reduced the prominence of natural dyes because they have advantages of color fastness, good reproducibility of shades, and brilliance of colors and ease of use over natural dyes [6]. However, extracts from natural source have been investigated by several scholars to be eco-friendly, non-toxic, biodegradable and compatible with the environment as compared to synthetic dyes that are suspected to cause allergies, may be carcinogenic and detrimental to health [7 & 8]. In view of these advantages, attention has been shifted to the use of natural dyes for dyeing textile materials [9 & 10]. In line with this assertion, several scholars have investigated dyestuffs from natural plants to replace the hazardous synthetic dyes and have presented excellent results. In previous report [11], extract from *Parthenium hysterophorus* weed which was applied on cotton and post mordanted with $CuSO_4$, alum and $SnCl_2$ resulted in a number of color imparted, with good fastness properties. Dyeing of cotton and jute fabrics with an aqueous extract of tea, containing tannins as the main colorant species had also been reported [12]. The dyeing was carried out and without metal salt as mordants, using three different dyeing methods: pre-mordanting, meta-mordanting and post-mordanting. The resulting wash and light fastness of the dyed fabrics were from good to excellent. *Parkia biglobosa* belongs to the kingdom plantae, order – fabales and family – fabaceae. It is commonly known as African locust bean. It is found in wide range of environments in Africa and is primarily grown for its pod that contains seed. The Igalas call it "Ukpehie", Yorubas call it "Iru", "Ogiri" in Igbo and "Daddawa" in Hausa. *Parkia biglobosa* is a dicotyledonous angiosperm, categorized under spermatophytes, vascular plants. It is a deciduous perennial plant that grows between 7 – 20 meters high, in some cases up to 30 meters. The tree is a fire resistant helophyte characterized by thick dark grey-brown bark. The pods of the tree commonly called locust been are pink in the beginning and turn dark brown when fully matured. When fermented and processed, the seed is used as condiment for cooking different meal, especially soup. It is known for its high nutritional value. The bark, root, leaves and flowers are used in traditional medicine to treat diversity of illness.

This plant is mainly a medicinal plant and hence its full value and potential should be effectively utilized to expand its application.

Materials and Methods

Parkia biglobosa bark was collected from Ankpa local government, Kogi State in September, 2019 and was identified and authenticated by a Professor Simon Sugei Usman and the specimen of the selected plant taken was deposited was deposited at our Institution's department of Biology. The extract was further obtained using absolute ethanol. The extract was used to dye cotton fabrics and color petroleum jelly (cosmetics), corn starch (food), and illicit gin (alcoholic drink). Analytical grade $CuSO_4$, $FeSO_4$, Alum and $K_2Cr_2O_7$ were the mordants used.

Plant preparation

The bark of the plant was collected, chopped into tiny pieces, dried and pulverized into fine particles for intimate contact with the absolute ethanol [13].

Extraction

From the pulverized sample 200 g was weighed into a container and 500 mL absolute ethanol was added. The mixture was allowed to stand for one week for effective extraction after which the mixture was filtered and the filtrate was evaporated to dryness and the solute collected and weighed.

Preparation of dye solution

1.0 g of the dye sample was weighed into a beaker, little amount of water was added to the dye sample to make a paste and was then made up to 100 mL.

Preparation of dye bath

25 mL of the dye solution already prepared was measured into a beaker and made up with water, to 100 mL.

Preparation of the fabric

The cotton fabric was scoured with soap and rinsed to enable the dye liquor to penetrate properly through the fiber to give uniform and level dyeing [1].

Dyeing process

Unmordanted dyeing

To the dye bath solution above, 2 g of the scoured fabric was introduced. The dyeing process commenced and lasted for 30 min at 60 ^{o}C. When the dyeing process was completed, the materials were removed from the dye bath and allowed to air oxidize for 10 min. Thereafter, they were rinsed with cold water to remove loose dye particles that adhered to the surface of the dyed materials. The dyed fabrics were then air dried after which the fastness properties were tested [14].

Mordanted dyeing

Pre - mordanting

Mordanting of the fabric was done by introducing the scoured fabric into 2 % solution of the mordants and warmed for 30 min at 60 ^{o}C. The fabrics were then removed and dyed in a dye bath at 60 ^{o}C for 30 min. The dyed fabric was oxidized for 10 min and later dried at room temperature. The color shade and fastness properties were compared with the unmordanted ones on a grey scale.

Simultaneous mordanting

2 g of the mordant was weighed and introduced into 100 mL of the dye bath. The mixture was heated to 60 ^{o}C and the fabric was immersed. Dyeing lasted 30 min. The dyed fabric was then removed, air oxidized for 10 min and rinsed in cold water, then air dried and tested for fastness.

Post mordanting

The scoured fabric was first dyed at 60 ^{o}C for 30 min after which it was transferred into the mordant solution at 60 ^{o}C and mordanted for 30 min. Thereafter, which the fabric was removed, air oxidized and rinsed in cold water, air dried and tested for fastness.

Fastness test

Light fastness

One set of the dyed textile fabrics was exposed to sunlight for one (1) week, while the other set was kept in the dark, wrapped in a black polyethene bag for the same period of time. The two sets were rated on a grey scale [15].

Wash fastness:

One set of the dyed fabrics was washed using mild soap and the other set was washed with detergent (strong soap) at 60 ^{o}C for 30 min and were air dried. The washed fabrics were compared with the unwashed on the grey scale [16].

Colouration of Substrates

Cosmetic Coloration:

Petroleum jelly, 100 g was weighed and melted. Then 2 g of the dye sample was weighed into a test tube and was dissolved using ethyl alcohol. The dissolved dye was introduced into the melted petroleum jelly and the mixture was heated to 80 ^{o}C with constant stirring to allow even mixture of the dye molecule. The mixture was cooled and the color imparted was visually identified [13].

Food Coloration (Corn starch):

100 g of corn starch was weighed and dissolved in 50 mL H_2O. 2 g of the dye sample was weighed into a glass beaker. Water was then added to make it up to 200 mL at 60 ^{o}C with continuous stirring. The dye solution was heated to boiling point. The boiling dye solution was poured into the corn starch solution in a 500 mL beaker and the mixture was stirred vigorously until a uniform molten corn starch meal was obtained. The imparted color was determined visually [17].

Alcoholic drink coloration:

2 g of the dye sample was weighed into a glass bottle, 100 mL of illicit gin was measured into the glass bottle and corked. The mixture was vigorously shaken for 10 min until a homogeneous mixture was obtained and the color produced was determined [10].

Results and Discussion

Table 1. Preliminary results

Sample	Colour or extract	Weight pulverized (g)	Weight extracted (g)	% yield	Solubility in cool H_2O	Solubility in warm H_2O
Bark of parkia biglobosa	Dark brown	200	12.93	6.3	Soluble	Soluble

Table 2. Colour shade and fastness properties for pre - mordanting.

Sample/mordantsmordantsmordants	Colour on fabrics	Light fastness	Wash fastness in mild soap	Wash fastness in strong soap
Bark of *Parkia biglobosa*	Brownish pink	2 -3	3 – 4	2 – 3
$CuSO_4$	Brown	3 - 4	3 – 4	3 – 4
$FeSO_4$	Ash	2 - 3	2 – 3	1 – 2
Alum	Light pink	2 - 3	3 - 4	2 – 3
$K_2Cr_2O_7$	Light pink	1 - 2	4 – 5	4 – 5

Table 3: Colour shade and fastness properties for Simultaneous mordanting

Mordants	Colour on fabrics	Light fastness	Wash fastness in mild soap	Wash fastness in strong soap
$CuSO_4$	Brownish pink	3 – 4	3 - 4	2 – 3
$FeSO_4$	Faint ash	2 - 3	3 - 4	3 - 4
Alum	Pinkish brown	2 - 3	3 - 4	4 – 5
$K_2Cr_2O_7$	Pinkish brown	2 – 3	4 - 5	4 ~ 5

Table 4: Color shade and fastness properties for post mordanting

Mordants	Color on fabrics	Light fastness	Wash fastness in mild soap	Wash fastness in strong soap
$CuSO_4$	Brownish pink	3 – 4	4 - 5	3 - 4
$FeSO_4$	Ash	3 - 4	4 - 5	3 - 4
Alum	Pinkish brown	2 - 3	4 - 5	4 - 5
K_2Cr2O_7	Brown	2 – 3	4 - 5	4 – 5

Key: 4 - 5 excellent fastness (Color retained)
3 - 4 = good fastness (Very slight color change)
2 - 3 = fair fastness (Slight color change)
1 - 2 = poor fastness (Most color change).

Table 5: Color impacted on Substrates.

Sample	Substrates	Color imparted
Bark of *Parkia biglobosa*	Corn starch	Pinkish brown
	Petroleum jelly	Light pink
	Illicit gin	Ox-blood

Dark brown extract was obtained in poor yield (6.46 %) and was soluble in both cold and warm water (Table 1). The color shade for pre-mordanting showed the unmordanted fabric color to be brownish pink with fair wash fastness in mild soap. $CuSO_4$ mordant imparted a brown color with good fastness to light and washing in both mild and strong soap. $FeSO_4$ mordant gave an ash color with fair fastness to light and mild soap. Alum and $K_2Cr_2O_7$ mordants imparted light pink colors with fair and poor light fastness respectively. Alum mordant showed good wash fastness in mild soap and fair wash fastness in strong soap while $K_2Cr_2O_7$ mordant displayed excellent wash fastness in both mild and strong soap (Table 2). Table 3 showed color shade of simultaneous mordanting with $CuSO_4$ mordant imparting brownish pink color with properties to light, good wash fastness in mild soap and fair wash fastness in strong soap. $FeSO_4$ showed a faint ash color with a fair fastness to light and good wash fastness in both mild and strong soap. Alum and $K_2Cr_2O_7$ presented a pinkish brown color both with fair fastness to light. Alum mordant gave good and excellent fastness in mild and strong soap respectively. $K_2Cr_2O_7$ showed excellent fastness in both soap.

Post mordanting of the fabrics showed $CuSO_4$ and $FeSO_4$ mordants to impart brownish pink and ash color respectively with both mordants having good fastness to light. $CuSO_4$ showed excellent fastness in mild soap and good fastness in strong soap and $FeSO_4$ showed good fastness in mild soap and fair fastness in strong soap. Alum and $K_2Cr_2O_7$ mordants both imparted brown color with fair light fastness and excellent fastness in mild and strong soap (Table 4). This research found that $K_2Cr_2O_7$ mordant displayed superiority over the rest across the mordanting types with post mordanting process showing enhanced color shade with better fixation properties. This is in agreement with an earlier report [18] which indicated that the dye extract from the flowers of *Acacia ebunea* (L.F) wild showed better fastness properties on cotton+ dyed using post mordanted method. The figures below give a pictorial illustration of our findings.

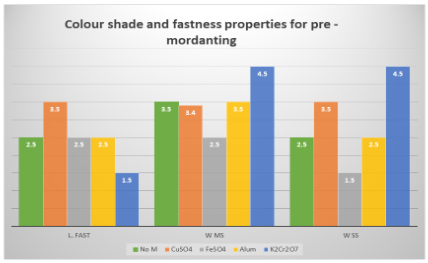

Fig. 1: Color shade and fastness properties for pre – mordanting

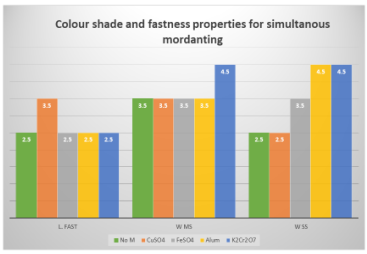

Fig. 2: Color shade and fastness properties for simultaneous - mordanting

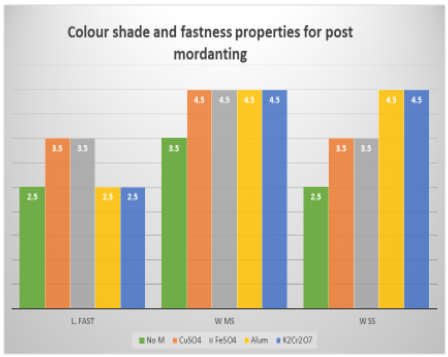

Fig. 3: Color shade and fastness properties for post – mordanting

The plant extract displayed beautiful color on the substrates. Corn starch, petroleum jelly and illicit gin showed pinkish brown, light pink and ox-blood Colors respectively (Table 5). The application on substrate was informed from the fact this plant is medicinal, used in Ankpa locality to treat certain illnesses.

Conclusion

Natural plants have been found to be less allergic, nontoxic, biodegradable and environmentally compatible. The findings of this work have revealed the wonderful color of the plant bark. With the varied color shades imparted on cotton fabrics we encourage its use as dye on cotton fabrics with $K_2Cr_2O_7$ mordant and post mordanting method for better hue and effective fastness and also as colorant on substrates by industries to substitute the injurious synthetic chemicals used in food, cosmetics, alcoholic drinks and on other substrates.

Abbreviation

Not applicable.

Recommendation

Based on our findings we recommend the use of this plant as dye and colorant by all a sundry.

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