Extraction, Purification, and Preliminary Characterization of Dyestuff from *Adansonia digita* Root (Baobaba)

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ABSTRACT

Dyes from the soft outer part of the root of *Adansonia digitata* was extracted successfully via cold maceration using ethanol and water successively. The extracted dye was recrystallized and characterized using a Janway 6405UV-Visible spectrophotometer. The isolated dye was tested for its color fastness to light, wash and rub on three (3) different textile fabrics. A dark-red coarse solid dye was successfully isolated from the root of Baobab in reasonable yields and its shows absorption maximum at 276.4 nm and 291.8nm for ethanol and water extracted dye respectively.

It was observed that wool absorbed the dye better than silk and cotton because its fastness to light, wash and rub. Base on the dye substantial yield and color fastness to light, wash and rub showed that *Adansonia digitata* (Baobab) is a valuable source for the natural dye and textile industries.

(Keywords: *Adansonia digitata*, dye extraction, characterization, dyestuff, purification)

INTRODUCTION

Dye is a natural or synthetic material, whether soluble or insoluble which impact its color to a material by staining or being imbibed by it, and which is employed from a solution of fine dispersion, sometimes with the aid of mordant (Okoli *et al*., 2015). They are widely used in textile, paper, leather and mineral processing industries to color their product. Different types of dyes are used in textile industries such as direct, reactive, acid and basic dyes (Dos *et al.,* 2007).

Most natural dyes were obtained from plant materials such as barks, root, fruits, seeds and flowers (Dweck, 2002). *Adansonia digitata* commonly called "Baobab" and "Kuka", "Oshe", "Igiose" in English, Hausa, Yoruba and Igbo respectively (Nwauzoma and Dapper,2013) and is one of the plants native to most of Africa, especially in dry, less tropical climates. It is not found in areas where sand is deep. It is sensitive to water logging and frost. It belongs to the family of Malvaceae (Bremer *et al*., 2003).

Adansonia digitata is a long-live tree with multipurpose uses. The fruit pulp of *A. digitata* is used in traditional medicine and it contains appreciable amount of Vitamin C (~ten times that of orange). It can be use as seasoning, as an appetizer, and to make juice (De Caluwe *et. al.,* 2010). Its seed and leaf can be eaten fresh or dried, ground into flour and thus added to soups and stews. The bark is used for treatment of fever, especially those caused by malaria. The fruits are used for treatment of Newcastle disease in poultry (Masola *et. al*., 2009).

This work is aimed at isolation of dyestuff from *Adansonia digitata root* and to determine its fastness to textile fabrics.

EXPERIMENTAL

Sample Collection and Preparation

The root of *Adansonia digitata* (Baobab**)** was collected from the Botanical garden, Department of Botany, University of Nigeria, Nsukka and identified by Dr. N.O. Nweze. The mould root was washed with tap water and allowed to dry. The soft outer part of the root stem was peeled off and sundried for two (2) week. The dried outer part of the root was pulverized using a mechanical grinder and stored in an air tight container for future use.

Extraction of Dye

The dyestuff was extracted from the pulverized soft part of the outer part of the root of *Adansonia digitata* via cold maceration method using ethanol and water successively as the solvent. Briefly, about 150 gram of pulverized plant material was macerated in 1800cm^3 of ethanol, the mixture was allowed to stand for 9 (nine) days with constant agitation at intervals. Then the mixture was filtered, and the filtrate was allowed stand for a period of time then the upper liquid was decanted. The solid portion was evaporated to dryness and a crude dark-red dye crystal was obtained. To the residue obtained from filtration, about 1800 cm^3 of distilled water was added and the mixture was placed on a mechanical shaker for constant agitation for the period 3 days to prevent fermentation. The mixture was filtered, and the process was repeated as described above for ethanolic extract.

The solid crystal obtained from both solvents was recrystallized in 1:2 ratio of ethanol to water solvent mixture, to obtain a pure crystal. The percentage yield was calculated using the formula below:

% yield = weight of the crystal obtained after recrystallization X 100 Weight of the starting plant material.

Characterization of the Dye

The physical characterization of the dye was carried out using the human sense organs. It chemical characterized using UV spectrophotometer.

Ultra-Violet Spectroscopy

The spectrophotometric data of the dye was carried out using Janway 6405 UV- Visible spectrophotometer. The UV absorbance of the dye was done by dissolving the dye in the solvent used for extraction. The spectrum was read and printed.

Dyeing Process

The dyeing ability of the dye extracted with water was tested on three different textile fiber namely: silk, cotton and wool. It fastness to light, washing and rubbing was also determined.

Post-mordanting (after chrome) method was used in dyeing the textile fibers. In this method, the dyed material is treated with a mordant and a complex is formed between the mordant and the dye on the fiber. In brief, about 6 gram of the dye stuff was dissolved in about 100ml of water to an homogenous solution and then the fibers were immersed into the dye liquor and allowed to stand for 10 mins after which Alum mordant solution (0.748g of Alum and 0.187g of Washing soda were mixed in 100ml of water) was added (Geetha and Samathy, 2013).

Color Fastness

Color fastness is the ability to keep original dye color under the influence different kinds of external factors used in the processes of dyeing textile. Examples of such external factors are light, rubbing, washing etc. This color change based fastness to light, washing and rubbing was assessed according to ISO 105-B01, ISO 105-C01 and ISO 105-X12, respectively.

RESULTS

Natural dyes from plant are currently search for because of the It's eco-friendly attribute when compared with synthetic dyes. The extractive percentage yield and color of dye obtained from baobab root using water and ethanol as solvent are shown in Table 1.

The color becomes darker as the temperature of the dye solution increases. The isolated dye is coarse in nature, it is moderately rough to touch testing and usually show poor adhesion and cohesion property. The melting point of the dye was difficult to ascertain as the dye chars at about 285-289^{0}C before the melting point is reached.

Table 1: Color and Percentage Yield of the Isolated Dye.

Dye source	Solvents used for extraction	Physical color of dye	% yield
Adansonia digitata	Water	Dark brown	6.333
	96% ethanol	Dark red	1.32

The UV-visible spectra of the dye obtained showed absorption at 276.4 nm (Abs: 0.610), 291.8 nm (0.327), 360nm (0.049) and 496.2nm (0.032) for dye extracted with ethanol and 291.8 nm (0.387), 295.6nm (0.102), 360nm (0.073), 406.6nm (0.059) and 493.2 (0.054) for that extracted with water as shown on the spectra in the table below.

The fastness to both rubbing and washing were measured according to a five-level standard scale while color fastness to light was measured based on eight level standard scale as shown in Table 2. Where '8' and '5' represent an outstanding fastness for both eight (8) and (5) level standard while '1' signifies poor fastness.

Table 2: Measurement of the Dye Color Fastness to Light, Wash, and Rub on Three Textile Fabrics.

Parameters	Silk	Cotton	Wool
Color fastness to light	4	5	6
Color fastness to wash	3	3	4
Color fastness to rub	4	4	5

DISCUSSION

Extraction is one of the major processing steps in obtaining natural dye for textile industries. It has both technical and commercial importance on the percentage yield of the dye, cost of extraction process as well as dyeing cost (Samantha and Konar, 2011).

Adansonia digitata has proven to be a good source of natural dye, the method of isolation is simple and less sophisticated. Hence, it's cost effective with a reasonable yield.

Natural dye of color ranging from red-brown can be obtained from the root or bark of plants, these colors are mostly based on the presence of anthraquinone (a class of flavonoids) and its derivatives in the plant.

UV- Visible spectra of natural dyes have both UV and Visible zone (190-700nm). They show peaks at predominant wavelengths indicating the mixture of color present in the dye (Samantha and Agarwal., 2009).

For instance, dye from Neem bark was reported to showed two (2) maximum absorption at 275nm and 374nm, Beet sugar dye was found to possess three (3) absorption band at 220nm, 280nm and 530nm, dye from Red Scandal wood also showed strong absorption at 504nm and 474nm in methanol solution and extracted dye from *Celosia cristata* flower showed one major peak at 533nm (Mathur et al., 2003; Muthur and Bhandari, 2003; Gulrajani and Bhanmik, 2003, Sankar and Vankar., 2005; Samantha and Agarwal., 2009).

UV-Visible spectra are useful in identification of the color mixture that made up the dye and gives some indicative information about the fading pattern and absorbance behavior of the dye under UV- light and sunlight. The UV-visible of *Adansonia digitata* in this present study showed absorption maximum at 276.4 nm and 291.8nm for ethanol and water extracted dye, respectively.

In textile industries, color fastness is a word used to characterize the textile fabric color's resistance to fading. The presence of mordants such as alum (potassium aluminum sulphate hydrate), ferrous sulphate, tin and copper are considered to improve the dye-ability and color fastness of the dye by enhancing molecular interaction between the dye molecules and the textile fabric.

Although, alum have proven to be reliable as observed in this research which is in agreement with Savvidi et al., 2013 and Zarkogianni et al., 2011 who reported that alum and ferrous sulphate are considered the safest among metallic salt mordant. Wool has shown better color fastness to light, wash and rub shown in Table 2.

CONCLUSION

The soft outer part of *Adansona digitata* root have been proven to be a gold mine for natural dye industries due to the relatively high percentage yield, the use of less sophisticated equipment and the cost-effective isolation process of the dye. The different hue pattern of the dye is observed in the UV-Visible spectra

showing absorption maximum at 276.4 nm and 291.8nm for ethanol and water extract, respectively.

This research has shown that dye obtained from the root of *Adansonia digitata* have a better affinity and color fastness for wool when compared with silk and cotton. Further study is required for the identification of the dye components.

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