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DYEING OF COTTON FABRIC USING ROSELLE

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ABSTRACT

Synthetic dyes used locally for dyeing of cotton fabrics comes with some consequential health implications. These synthetic dyes apart from being harzadous in nature, are also very expensive and sometimes inaccessible to some places for lack of funds to purchase them. It becomes imperative to extend research to other sources of dyes precisely natural sources which are eco-friendly and medicinal in some cases. These dyes can be used by local dyers and even industries for the colouration of textile materials, food, cosmetics and pharmaceuticals. The extraction of dye from roselle is hereby reported. The dye was extracted using ethanol as solvent by varying the extraction condition. A maximum yield of about 71.2% was obtained. The extracted dye was applied on cotton fabric using chrome as mordant at varying dyeing conditions. The results of the analysis showed a good wash and light fastness.

Keywords*: Natural dye, Mordant, Cotton fibre, Dyeing and Roselle.*

1.0 INTRODUCTION

Natural dyes are colourants which are gotten from animal or vegetable matter without any chemical processing. Natural dyes are widely used in several sectors, such as colouring of food substrate, wood, leather, as well as natural fibers like silk, wool, cotton and flax since ancient times. Natural dyes have a wide range of shades that can be obtained from various parts of plants, including roots, bark, leaves, flowers and fruits (Gulrajni and Gupta, 1992). They are mostly eco-friendly, biodegradable, less toxic, and less allergenic as compared to synthetic dyes. However, studies have shown that certain natural dyes may have detectable mutagenic effects e.g., elderberry colour and safflower yellow; others, like carmine, can cause asthma by continuous inhalation. But it can be said that most of the natural dyes are safe and some even have curative effects e.g., curcumin in turmeric and walnut has antibacterial properties (Gulrajni and Gupta, 1992).

Natural dyes obtained from mineral, plant and animal sources are attractive, beautiful and sometimes they brought a lot of challenges to researchers and educators as compared with synthetic dyes (Emishili, 2001).

Natural dyes extracted from the roots, leaves, stems or bark and flowers of various plants have various exceptions and have no substantivity to textile fiber except when applied in conjunction with mordants o enhance its substantivity (Evans and Stapleton, 1971).

Recently, a number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes (Collier and Tortora, 2001).

Roselle is a plant of the malvaceae family and is native to the tropical areas such as Indonesia. Along with agricultural technologic progress, anthocyanin compound is found in roselle petals and it also can serve as a source of antioxidants (Hayati *et al.,*2012). It is good for health because of its high antioxidant properties, and anthocyanin which in itself can be used as natural dye. Using natural dyes in food products is better and safer compared to synthetic dyes. Most synthetic dyes give a negative impact on human health when ingested. The most dominant anthocyanins of roselle petals are delphinidin-3-sambubioside and cyanidin-3-siambubioside (Molyneux, 2004) and they responsible for the red colour in roselle plant. Anthocyanins are derivatives of the basic flavylium cation structure, which are highly reactive. The rate of anthocyanin destruction depends on many factors such as temperature, pH, ultraviolet light, and oxygen. Anthocyanin dyes can be applied to food and drink products, such as jam, soft drinks, milk, and yoghurt (Bhagwat *et al.,* 2014).

However, the natural dyestuffs extracted from roselle petals are known as subjective dyes require some mordants to attach the colour on the fibers and form strong chemical bonds. The mordant enters deeply into the fibre and combines with dyestuff to form the colour (Chumsri *et al.,* 2008). Compounds of potassium alum, tannic acid, and ferrous sulphate are the safest choices, they combine with the dyestuff and are then permanently fixed onto the fibre.

The present work is aimed at determining the effect of mordant on the fastness properties of dyed cotton fabric and the determination of the optimum dyeing condition using roselle dye extract.

2.0 MATERIALS AND METHOD

2.1 APPARATUS

The apparatus used are: Round bottom flask, Soxhlet, Heating mantle, Magnetic stirrer, Thermometer, Measuring cylinder, Glass rod, Desiccator, Spatula, Filter paper, Hot plate, Sodium sulphate, Ethanol, Sodium carbonate, Potassium chromite, Sodium hydroxide.

2.2 SAMPLE PREPARATION

Cotton fabrics were obtained from Dutse, Jigawa state market and cut into pieces of specific weight. The cotton fabric was washed with warm water to remove oil, and alkali solution (NaOH) was used to removed other dirt and oil stain from the cotton material, it was then rinsed thoroughly with water and dry under shade. The textile fabric was washed with soap and detergent so as to make the fabric lighter and to remove other undesirable substances from the cotton fabric in other to increase its affinity towards dye extract.

2.3 SAMPLE EXTRACTION

Roselle petals were obtained from Dutse local government, Jigawa state. It was dried under the sun for 3 days and kept in polyethylene bag to keep away from dust and moisture. It was then crushed into a fine particle using domestic blander, 40 g of the crude dried powdered was weighed and mixed with 250ml of ethanol. The roselle dye extract was extracted from the resulting mixture using soxhlet extractor for a period of 4-6 hours. The dye extract solution was concentrated and evaporated using hot plate evaporator. The percentage yield of the dye extract obtained was calculated.

2.4 DYEING PROCESS

2.4.1 Dyeing Without Mordant

5g of dye extract were dissolved in beaker, containing 30 ml of ethanol. The solution was warmed mixed thoroughly to obtained uniformity, 2g of cotton fabric was wet and then introduced in to the dye bath and subjected to stirring and boiling for about 60 minutes.

2.4.2 Dyeing With Mordant

About 1.0g of chrome (potassium chromate) was dissolved in a Beaker containing 30 ml of ethanol and 5 g of dye extract. The solution were warmed and 2 g of the fabric sample, was wet and then introduced in to the dye bath and subjected to stirring and boiling for about 60 minutes.

Aqueous Dyeing

This dyeing process was carried out in bath containing of 30 g/l potassium chromate and 2 g/l sodium carbonate. The wetted fabric 2 g was immersed in the dye bath containing only the 5 g of dye extract in 30 ml of cool water, and subjected to stirring for about 15 minutes, the dye bath was heated to 90 °C for about 20 minutes, then 500 ml of potassium chromate was added when the 90°C was reached, 10% sodium carbonate solution was then added in the dye bath. The temperature was maintained for another 60 minutes with stirring.

COLOUR FASTNEES TEST

This test was used to measure the resistance of the textile fabrics when exposed to various factors during their useful life such as washing, rubbing etc.

Fastness to Washing

Assessment of washing fastness is made by series of five washing test varying in severity from number 1 to number five. The degree of staining is assessed by matching the appropriate undyed piece of fabric to the specimen using grey scale.

Fastness to Rubbing

A machine known as crockmeter was used to test the fastness to rubbing or crocking. A relatively simple test is to rub the dyed fabric with a piece of undyed fabric wrapped round the finger, the first with white dry and then with wet white fabric, which will stain the white fabric and the fastness to rubbing property is determined.

RESULT AND DISSCUSSION

Yield Content

The yield of roselle's extract was calculated as X = (weight of extract after evaporating/weight of dried roselle before extracting) x 100%. Based on the results of this study, the highest yield contents were obtained as:

Weight of extract after evaporating = 28.48g
Weight of dried roselle before extracting = 40g

$$Yield\ (\%) = \frac{\text{weight of extract after evaporating}}{\text{weight of dried roselle before extracting}} \times 100$$

Colour strength

Colour strength was calculated using kubelka-munk equation and was obtained as shown in Table 1.

Table 1: Colour Strength of dyed materials under different conditions.

Colour strength K/S for the samples		
Dyeing without mordant	Dyeing with mordant	Aqueous dyeing
2.75	8.78	10.24

From the above table the colour strength was found to be different due to mordant and varying of the dyeing medium. The result obtained indicates that, introduction of the mordant was found to produce colour strength higher than the one without mordant. This is because mordant creates a chemical affinity between the fibre and the dye and so enable the dye to retain on the fiber, while one without mordant can be easily wash away due to inability of natural dyes to be retain on textile materials in the absence of mordant. Aqueous dyeing medium has the highest colour strength than ethanol dyeing medium, because there is difference in polarity between them, and dyeing in aqueous medium will be retain more than that of ethanol medium, and only caused slight change to the colour strength obtained.

Fastness testing

Table 2: Fastness Properties of Fabric Dyed Without Mordant.

Wash fastness		**Dry rubbing**		**Wet rubbing**	
Alteration 2	Staining 2-3	Alteration 2	Staining 2-3	Alteration 2	Staining 2-3

In table 2 dyeing was found to have poor fastness to washing and rubbing due to the absence of mordant in the dye bath, during the dyeing process, and the dye molecule where not fix on the available dye site on the fiber, and so can be easily remove.

Table 3: Fastness Properties of Fabric Dyed With Mordant.

washing fastness		**Dry rubbing**		**Wet rubbing**	
Alteration 3	Staining 3-4	Alteration 4	Staining 4-5	Alteration 3	Staining 3-4

In table 3 dyeing was found to have good fastness to washing and rubbing, due to the introduction of mordant in the dye bath, during the dyeing process, and the dye molecule where fixed on the available dye site on the fiber.

Table 4: Fastness Properties of Fabric Dyed In Aqueous Medium.

washing fastness		**Dry rubbing**		**Wet rubbing**	
Alteration 4	Staining 4-5	Alteration 4	Staining 4-5	Alteration 3	Staining 3-4

In table 4 dyeing was found to have very good fastness to washing and rubbing, due to the introduction of mordant in the dye bath, during the dyeing process , and the dye molecule where fixed on the available dye site on the fiber.

CONCLUSION

The percentage yield of the dye extract was found to be 71.2%, small portion of the dye extract was used to dye fabrics under different dyeing conditions. The dyed fabrics were of different colour strength depending on the mordant and dyeing medium used.

From the results of the findings, it shows that Roselle can be used in the dyeing of cotton fabric to obtain good results when mordants are used in conjuction with the dyeing process. The wash and rubbing fastness here seen to improve on application of chrome mordant which enhances the interaction between the dye and the fabrics.

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