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Chemical and Physical Evaluation of Natural Dyes from Hibiscus Sabdariffa Linn (Zobo), Bamphia Nitida (Camwood) and Indigofera Tinctoria (Tropical Indigo Plant)

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Abstract
Extraction and characterization of natural dye from Hibiscussabdariffalinn (Zobo), Bamphianitida (camwood) and Indigoferatinctoria (Tropical indigo plant) was studied to ascertain the optimal yields of dye extract using different solvents. Different plants gave yields within the range of 0.5-3.5g. The optimal yields of dye extracts were subjected to UV-analysis. The absorption peaks for Hibiscussabdariffalinn (zobo), Bamphia nitida (camwood) and Indigoferatinctoria (Tropical indigo plant) were obtained using a UV-spectrophotometer and the maximum absorptivity using ethanol, methanol and acetone solvents were found to be 2.350, 3.524 and 1.560 respectively. The highest peaks were deduced from the graph at 500xmax for Hisbiscussabdariffalinn (zobo) 340xmax for Indigofera tinctoria (Tropical Indigo plant) and 480xmax for Bamphia nitida and azo group. The pretreatment of the cotton fabric with two different mordants (Aluminum potassium sulphate and potassiumdichromate) showed that the mordanted cotton fabric using potassium dichromate was unable to penetrate the dyestuff while the mordanted cotton fabric using aluminium potassium sulphate was able to penetrate the cotton fibric. The mordanted cotton fabric had a better absorption of dye compared to the unmordanted fabric. The result of fastness test showed that cotton fabric has a good affinity for dye.

Keywords: *Chemical and physical evaluation, Natural Dyes, Hibiscus Sabdariffa Linn, Bamphia Nitida, Indigofera Tinctoria*

1. Introduction

Natural dyes have been used extensively since long periods. It was practiced during the Bronze Age in Europe. The earliest written record of the user of natural dyes was found in China dated 2600BC (Siva, 2007). The colour of a dyed fabric depends on the nature of the chromophones (the coloured portion of a dye) as well as the substituent functional groups, the auxochromes (certain functional groups which slightly alters the colour) of the dye molecular species (Padma, 2000). Dye may be defined as coloured substances which impact more or less permanent colour to other materials. Such substances with considerable colouring capacity are widely employed in the textile, pharmaceutical, food, cosmetics, plastics, photographic and paper industries (zollinger, H, carneiro, P.A. 1987). Majority of natural dyes need a chemical in the form of metal salts to create an affinity to the fibers and pigment. These chemicals are called mordants. Common mordants used are alum, chrome, copper sulphate, ferrous sulphate etc. (Siva, 2007), Mahangade et al 2009, Samanta and Agarwal, 2009). Hisbiscussabadariuffalinn (Zobo) is a shrub belonging to the family malvaceae. The leaf is reported to contain protein, fat, carbohydrate, fibre, calcium, phosphorus, iron, thiamine, riboflavin, miancin and ascorbic acid (Watt, J.M and Breyer, et al, 1962). The flower yields a purple dye, the major pigment identified is daphriphylline (as above). Bamphianitida (camwood) also known as African sandal wood is a shrubby, hard-wooded African tree. Its wood is commonly used to make a red dye. The source of the indigo dye is the many species of genus indigofera called elu which often times grow wild throughout Nigeria. The name “indigo” derived from Latin word indicum implying from India (Noah

B. 1995). In order to overcome the menace of synthetic dyes, there is need to focus on future researches since natural dyes have better biodegradability and generally have higher compatibility with the environment. (Adeel et al, 2009).

2. Experimental

2.1. Pretreatment of Raw Material for Hibiscus Sabdariffalinn (Zobo)

The 30kg of samples of Hibiscussabdariffa (zobo), Bamphianitida (camwood) and indigoferatinctoria (Tropical indigo plant) were collected and washed thoroughly with water to remove impurities. After drying at room temperature, the samples were ground into powder with the help of grinder (Win and Swe, 2008).

2.2. Extraction of Dyestuff from Hisbiscussabdariffalinn, Bamphianitida and Indigoferatinctoria (Tropical Indigo Plant)

50g of samples of the various raw materials were weighed and taken into a round bottom flask and 350ml of solvent (ethanol) was added to it. The content of the flask was heated in a water bath at 60^0C for 60mins. The solution was filtered to obtain the crude dyestuff. The same procedure was repeated using n-hexane, methanol and acetone as solvents (Win and Swe, 2008; Goodarzin and Ekrami, 2010).

2.3. Purification of Crude Dyestuff

The extracted dyestuff from Hibiscussabdariffa (zobo), Bamphianitida (camwood) and indigoferatinctoria tropical indigo plant were distilled to get one third of the solution using the soxhlet apparatus at 65^0C for 1-hour 30mins respectively.

In the process ethanol, methanol, acetone and n-hexane were recovered and the concentrated dyes were obtained. The solutions were kept overnight at room temperature and after which they were dried in the oven overnight at 60^0C (Win and Swe, 2008; Goodazian and Ekrami, 2010).

2.4. Characterization of Purified Dyestuff

10ml of the various aqueous dye extract were diluted in 100ml of pure distilled water. An aliquot was introduced in a quartz cell (1cm pathway) and analyzed in a 722s spectrophotometer. A scan from 330nm to 530nm was performed in order to generate the characteristic absorption of the various samples.

2.5. Scouring of Cotton Fabric

Scouring of cotton clothes was done by washing them in solutions containing 1.5gllit. Sodium carbonate and 6g/l ionic detergent at 50^0C for 25mins, keeping the materials to liquor ratio. The scoured cotton was thoroughly washed with tap water and dried at room temperature. Then the scoured materials were soaked in clean water for 30mins prior to dyeing or mordanting.

2.6. Mordanting Of Cotton Fabric

0.5g potassium dichromate was weighed and dissolved in a 250ml beaker at a temperature of 85^0C. cotton fabric (15cm by 15cm) weighing approximately 2g was treated with enough water to cover the fabric in the beaker. The temperature of the solution was increased for 15minutes with continuous stirring. The mordanted cotton was allowed to cool and then rinsed with water before dyeing. The same procedure was repeated with aluminum potassium sulphate.

2.7. Dyeing of Cotton Fabric

1g of the various dyestuff were weighed and dissolved in a 250ml beaker. Cotton fabric (15cm by 15cm) weighing 2g was added to the beaker at a temperature of 90^0C. the temperature of the solution was increased for 10mins with continuous stirring. The dyed cotton was brought out and hung on a retort stand for drying at room temperature.

2.7.1. Fastness Test

The dyed materials were tested for light fastness, wash fastness and rub fastness. The colour fastness is usually rated either by loss of depth of colour in original sample. Light fastness was analyzed by exposing the dyed materials to direct sunlight for 24hrs. the wash fastness was carried out by washing the dyed fabric with toilet soap (1g/l). The rub fastness of the dyed fibric was carried out by rubbing the cotton and checking for fading of colour.

3. Discussion

Results for the extraction of dyestuffs from Hibiscus sabdariffalinn (zobo), Bamphianitida (camwood) and Indigoferatinctofera (Tropical indigo plant)

Ethanol Extract	Methanol Extract	Acetone Extract	N-hexane Extract
3.5g	3.0g	2.6g	1.4g

Table 1: Hibiscus Sabdariffalinn (Zobo) 50g

Ethanol Extract	Methanol Extract	Acetone Extract	N-hexane Extract
1.5g	1.8g	2.1g	1.3g

Table 2: Indigoferatinctoria (Tropical Indigo Plant) 50g

Ethanol Extract	Methanol Extract	Acetone Extract	N-hexane Extract
1.3g	1.4g	0.7g	0.5g

Table 3: Bamphianitida (Camwood) 50g

The absorption spectra generated during the UV-visible analysis of the dye extract shows the following: The characteristic reddish-purple colour manifested by the dye extract from zobo could be the consequence of the presence of compounds derived from certain group. A maximum absorption peak (λ_{max}) was detected at 500nm. The value shows that the wavelength of the sample fall between the blue-green region in the visible spectrum. At 500λ_{max} the chromophore present in Hisbiscussabdariffalinn (zobo) was found to be a Thio group and a transition of n- π^*.

A brownish black extract was obtained from Bamphia nitida (camwood). A maximum absorption peak (λ_{max}) was detected at 485nm for Bamphianitida (camwood) which shows that it's within the green-blue region in the visible spectrum. At 485λ_{max} the chromophore present in Bamphianitida (camwood) was found to a Nitro group and a transition of n-π^*.A deep green extract was obtained from Indigoferatinctoria (tropical indigo plant). A maximum absorption peak (λ_{max}) was detected at 340nm for Indigoferatinctoria (Tropical Indigo plant). At 340λ_{max} the chromophore present in indigo plant was found to be an Azo group and a transition of n- π^*.

Different shades of purple were obtained from the dye extracted from H. sabdariffalinn (zobo) at different concentration when dyeing the cotton fabric. The cotton fabric was mordanted using potassium dichromate which was immediately used for dyeing but was unable to penetrate the dyestuff from Hisbiscussabdariffalinn due to the inability of the mordant to form coordination complex with the dye extracted from H. sabdariffalinn (zobo). The unmordanted cotton for H. sabdariffa was not resistant (fastness) to the cotton fabric. The dyed cotton fabric was able to penetrate the mordanted using aluminium potassium sulphate but the colour changed to violet after washing with toilet soap.

The extract from Bamphianitida (camwood) was a brownish black dye. The extract was insoluble in water and could not penetrate the cotton fabric due to the oil content of the plant, but was able to stain my hand for days during the pre-treatment of the plant.

Indigoferatinctoria (Tropical Indigo plant) extract was insoluble in water and was unable to penetrate the cotton fabric. But when ethanol solvent was used, a deep green colour was obtained. The deep green colour of the indigo plant extract changed to lemon after washing with toilet soap. The cotton material was mordanted with aluminium potassium sulphate and a lemon colour fabric was obtained.

4. Conclusion

Natural dyes are notable for their bright colours to fabrics. They can be used in textiles, pharmaceutical, food, cosmetics, plastics, photographic and paper industries. The process of extraction and dyeing is environmentally friendly. Use of mordants can also be considered for improving the fastness of dyed clothes. Further research will help to explore the undiscovered important uses of dye extracted from Hisbiscussabdariffalinn (zobo), camwood and Tropical indigo plant.

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