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Effect of Mordants on some selected plant based Natural dyes

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Abstract: The aim of this work is to study the application of mordants on natural dyes by carrying out three methods such as pre mordanting, post mordanting and meta mordanting using Lead acetate, potassium dichromate and ferric chloride as mordants. In this study leaves of Justiciavasculosa (Nees) T.Anderson and Altenanthera , whereas seeds of Areca catechu L. plant were used. The extraction process is carried out simply by taking the plant sample and undergoing extraction processes such as aqueous, alkali and solvent extraction. Phytochemical screening and functional group test were also performed on the extracted dyes. The extracted dyes were analyzed under visible - UV light and IR spectroscopy and prominent characteristic peaks were detected and their absorbance was recorded. Different shades were obtained when the natural dye was applied to the cotton fabrics in different mordants and mordanting process.

Key words: Ferric chloride, Lead acetate, Phytochemical, Potassium dichromate, Mordants.

Introduction:

Natural dyes are frequently utilized in the textile industry because of less negative impacts compare to synthetic dyes. Natural dyes can be used on various textiles, including cotton, silk, and wool. Due to their hues' stability and lack of irritants for human skin, they are environmentally benign. Due to the adverse impact on the environment, and the presence of carcinogenic properties and toxicity of the synthetic dyes, the natural dyeing process have been gaining much attention in the present days because it is eco-friendly and possess. Nature has provided verities of plants which can be used in dyeing of different products and are safe for human beings to live happily. The biodiversity of our country has provided us plenty of raw materials, yet sustainable linkage must be developed between cultivation, collection and their use (Kumarsan et. al., 2011). The Natural dyes fall into three categories on the basis of their origin: plant, animal and mineral (Jihad, 2014). Given that they provide color and fragrance, floral dye sources are far more important for textile dying than other plant-based dye sources like bark, blossoms, seeds, etc. (M. Santhi et al., 2021,). The natural plants used for dye extraction are classified

as medicinal and some of these have recently shown to possess antimicrobial activity. (Chungkrang and Bhuyan 2020, R. Siva.2007). They are used not only in textile dyeing and functional finishing (antimicrobial, deodorizing or UV protective), but also as food and cosmetic colorants, cosmetic healing additives, pH indicators and in several other uses (Carvalho and Santos, 2016). Mordants play important role in imparting color to the fabric. The mordants used in combination in different ratios gave varying shades. Better color strength results are dependent on the metal salt used (Mehrabian et. al., 2000). Strong co-ordination tendency of iron enhances the interaction between the fiber and the dye, resulting in high dye uptake (Jothi D, 2008). All natural dyes based on the vegetable origin are renewable (Chavan, 1995; Paul et. al., 1996 and Gupta, 1990). Natural color is gaining popularity in textile industry due to their eco- friendly and desire colorant (Shahid et. al., 2018). Natural dyes have other functional properties such as anti-fungal, anti-viral activity (Gupta et. al., 2004), insect repellent (Ali et. al., 2013), UV protection (Sun and Tang, 2011) antimicrobial activity (Khan et. al., 2012; Shahid et. al., 2013), and deodorizing agents (Lee et. al., 2009) in addition to their biodegradable and eco-friendly character.

GEOGRAPHY OF PLANTS

1. Justiciavasculosa (Nees) T.Anderson Family: Acanthaceae

Botanical name: Justiciavasculosa (Nees) T.Anderson Local name: Narang (Ao)

This is a type of shrubs that grown in length of up to 4-5ft.The leaf of this plant is eaten after a simple boil. The sample was collected from Jotsoma village of Kohima district, Nagaland.

2. Altenanthera sp. Family: Amaranthaceae

Botanical name: Altenanthera sp. Local name: Kotak naro (Ao)

This is a woody- based sub-shrub that grows up to 4-5 ft whose stem and leaves are both reddish pink in color with seasonal golden yellow flower. Due to its richness in color they are also used as a decorative plant. The sample was collected from Jotsoma village.

3. Areca catechu L. Family: Arecaceae

Botanical name: Areca catechu L. Local name: Kozu (Ao).

This plant is of the species of palm, they are mostly found in Asia, tropical pacific. Areca catechuis grown mainly for its commercial uses of its seed, which is the key ingredient of betel nut chewing. The sample was collected from Yaongyimsen village.

Fig-1: Justiciavasculosa leaves

Fig-2:Altenanthera leaves

Fig-3a: Areca catechu seed

Fig-3b: Areca catechu plant

METHOD FOR THE EXTRACTION OF DIFFERENT NATURAL DYES

Three methods of extracting natural dyes from plant sources were used.

Aqueous extraction: Plant samples are crushed into smaller pieces or paste. The sample is moved into a beaker, and 3-4 times the sample amount is supplemented with distilled water. After boiling the material for 15 minutes,

it is filtered. To color the cotton fabric, the filtrate is stored after being boiled to half of its original volume. After that, the residue is left to dry.

Alkali extraction: Crushed plant samples were boiled for a 15 to 20 minutes. Two to four times the amount of the sample is dissolved in 2N NaOH solution. After the content is filtered, the filtrate is boiled once more to reduce its volume and is stored until the cotton fabric is dyed.

Solvent extraction: 10g of the plant sample is dried and placed into a filter paper pouch and put into the soxhlet apparatus's siphon tube. The equipment has a round-bottom flask at the bottom that holds roughly 250 ml of methanol (solvent). It takes nearly six hours to extract.

METHODOLOGY

Methods of mordanting and material required

Three methods **(**Pre-, trans- and post-mordanting) were used for mordanting.

Mordant used: Aqueous solution of Lead acetate (CH_3COOPb), Potassium dichromate ($K_2Cr_2O_7$) and Ferric-chloride ($FeCl_3$) were used in the mordanting of the three natural dyes.

Materials required: Plant sample (Leaves of plant 1 and 2 whereas seeds of plant 3).

Functional Group Test:

Table-1: Functional group test (aqueous extraction)

Functional Group	Test	Plant Samples	Results
Carboxylic group (-COOH)	Sodium bicarbonate test	Justiciavasculosa (Nees) T. Anderson	Absent
		Altenanthera sp.	Absent
		Areca catechu L.	Absent
Alcoholic group (-OH)	Ceric ammonium nitrate test	Justiciavasculosa (Nees) T. Anderson	Absent
		Altenanthera sp.	Absent
		Areca catechu L.	Present
Phenolic group (-OH)	Ferric chloride test	Justiciavasculosa (Nees) T. Anderson	Absent
		Altenanthera sp.	Present
		Areca catechu L.	Absent
Carbonyl group (both aldehyde and ketone)	2,4-DNP test	Justiciavasculosa (Nees) T. Anderson	Absent
		Altenanthera sp.	Absent
		Areca catechu L.	Absent
Amino group ($-NH_2$)	Azo dye test	Justiciavasculosa (Nees) T. Anderson	Present
		Altenanthera sp.	Present
		Areca catechu L.	Present

PHYTOCHEMICAL TEST

Table-2: phytochemical test (aqueous extraction)

Test	Sample	Results
Alkaloids	Justiciavasculosa (Nees) T. Anderson	Absent
	Altenanthera sp.	Absent
	Areca catechu L.	Present
Steroids	Justiciavasculosa (Nees) T. Anderson	Present
	Altenanthera sp.	Present
	Areca catechu L.	Present
Flavonoids	Justiciavasculosa (Nees) T. Anderson	Absent
	Altenanthera sp.	Absent

	Areca catechu L.	Absent
Tannins	Justiciavasculosa (Nees) T. Anderson	Present
	Altenanthera sp.	Absent
	Areca catechu L.	Absent
Glycosides	Justiciavasculosa (Nees) T. Anderson	Present
	Altenanthera sp.	Present
	Areca catechu L.	Present
Terpenoids	Justiciavasculosa (Nees) T. Anderson	Absent
	Altenanthera sp.	Present
	Areca catechu L.	Present
Saponins	Justiciavasculosa (Nees) T. Anderson	Present
	Altenanthera sp.	Present
	Areca catechu L.	Present

RESULTS AND DISCUSSION

Color obtained in different mordant where, (a) is CH_3COOPb, (b) is $K_2Cr_2O_7$, and (c) is $FeCl_3$.

Sample -1: (aqueous extraction)

(a) Pre mordanting (b) Pre mordanting (c) Pre mordanting

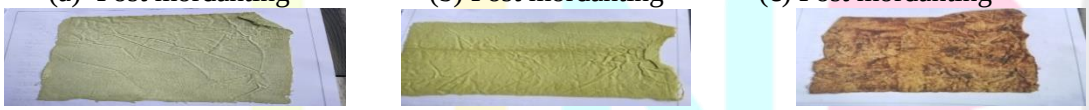
(a) Post mordanting (b) Post mordanting (c) Post mordanting

(a)Trans mordanting (b) Trans mordanting (c) Trans mordanting

Sample -1: (alkali extraction)

(a) Pre mordanting (b) Pre mordanting (c) Pre mordanting

(a) Post mordanting (b) Post mordanting (c) Post mordanting



(a) Trans mordanting (b) Trans mordanting (c) Trans mordanting

Sample -1: (solvent extraction)

(a) Pre mordanting (b) Pre mordanting (c) Pre mordanting

(a) Post mordanting (b) Post mordanting (c) Post mordanting

(a) Trans mordanting (b) Trans mordanting (c) Trans mordanting

Sample -2: (aqueous extraction)


(a) Pre mordanting


(b) Pre mordanting

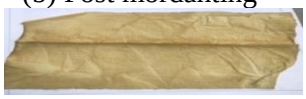

(c) Pre mordanting


(a) Post mordanting


(b) Post mordanting


(c) Post mordanting


(a) Trans mordanting


(b)Trans mordanting


(c) Trans mordanting

Sample -2: (alkali extraction)


(a) Pre mordanting


(b) Pre mordanting


(c) Pre mordanting


(a) Post mordanting


(b) Post mordanting


(c) Post mordanting


(a) Trans mordanting


(b) Trans mordanting


(c) Trans mordanting

Sample -2: (solvent extraction)


(a) Pre mordanting


(b) Pre mordanting


(c) Pre mordanting


(a) Post mordanting


(b) Post mordanting


(c) Post mordanting


(a)Trans mordanting


(b) Trans mordanting


(c) Trans mordanting

Sample -3: (aqueous extraction)


(a) Pre mordanting


(b) Pre mordanting


(c) Pre mordanting


(a) Post mordanting


(b) Post mordanting


(c) Post mordanting


(a) Trans mordanting


(b) Trans mordanting


(c) Trans mordanting

Sample -3: (alkali extraction)


(a) Pre mordanting


(b) Pre mordanting


(c) Pre mordanting


(a) Post mordanting

(b) Post mordanting

(c) Post mordanting

(a) Trans mordanting (b) Trans mordanting (c) Trans mordanting

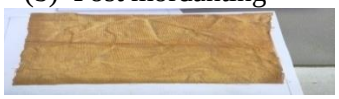
Sample -3: (solvent extraction)



(a)Pre mordanting (b) Pre mordanting (c) Pre mordanting



(a) Post mordanting (b) Post mordanting (c) Post mordanting


(a) Trans mordanting (b) Trans mordanting (c) Trans mordanting

Table 3: Effect of mordants on ***Justicia vasculosa (Nees) T.Anderson***

Extraction process	Mordants	Pre mordanting process	Post mordanting process	Trans mordanting process
Aqueous extraction	CH_3COOPb	British khaki	Khaki brown	Light tan
	$K_2Cr_2O_7$	Mink	Yellowish brown	Light coffee brown
	$FeCl_3$	Dark yellowish brown	Golden dark brown	Flax
Alkali extraction	CH_3COOPb	Light turkish	Silver green	Cream green
	$K_2Cr_2O_7$	Tea green	Golden green	Light greenish brown
	$FeCl_3$	Reddish brown	Golden brown	Dark copper red
Solvent extraction	CH_3COOPb	Olive green	Silver green	Silver green
	$K_2Cr_2O_7$	Yellowish brown	Yellow brown	British khaki
	$FeCl_3$	Muted brown	Golden brown	Yellowish brown

Table 4: Effect of mordants on ***Altenanthera sp.***

Extraction process	Mordants	Pre mordanting process	Post mordanting process	Trans mordanting process
Aqueous extraction	CH_3COOPb	Mud brown	Silver brown	Faded brown
	$K_2Cr_2O_7$	Khaki	Dull brown	British khaki
	$FeCl_3$	Copper brown	Gold brown	British tan
Alkali extraction	CH_3COOPb	London stone	Light cream	Cream tan
	$K_2Cr_2O_7$	Dark khaki	Light brownish yellow	Greenish yellow
	$FeCl_3$	Brown	Golden yellow	Copper brown
Solvent extraction	CH_3COOPb	Light creamy brown	Cream	Green cream
	$K_2Cr_2O_7$	Golden brown	Light brown	Brown taupe
	$FeCl_3$	Golden brown	Yellowish brown	Meri gold

Table 5: Effect of mordant on ***Areca catechu L.***

Extraction process	Mordants	Pre mordanting process	Post mordanting process	Trans mordanting process
Aqueous extraction	CH_3COOPb	Muted tangerine	Silver red	Light sangria red
	$K_2Cr_2O_7$	Golden brown	Light golden brown	Light cider
	$FeCl_3$	Taupe	Dark gold	Faded yellow brown
Alkali extraction	CH_3COOPb	Faded brown red	Light cider	Light brick red
	$K_2Cr_2O_7$	Orange brown	Yellow orange	Light bronze
	$FeCl_3$	Faded brown	Apricot	Light wine red
Solvent extraction	CH_3COOPb	Creamy brown	Sage brown	Faded creamy brown
	$K_2Cr_2O_7$	Orange brown	Yellow brown	Orange brown
	$FeCl_3$	Meri gold	Bronze	Apricot orange

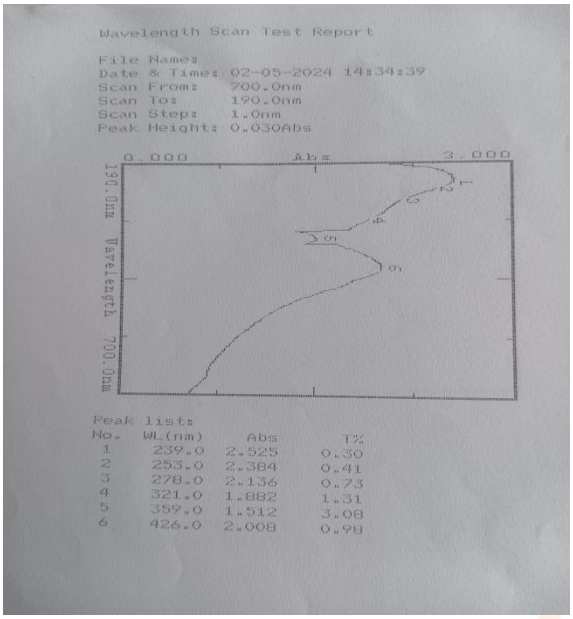


Fig-4a: UV spectrum of sample-1.

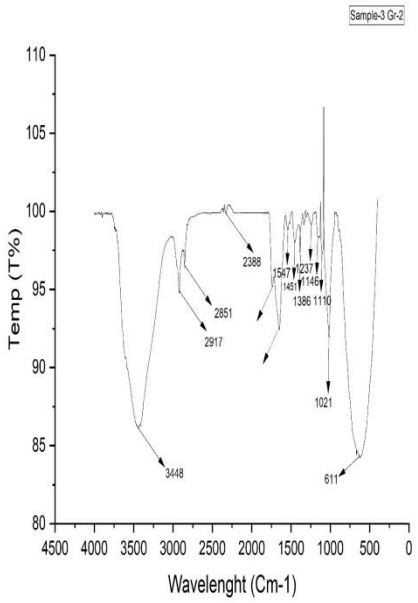


Fig-4b: IR spectrum of sample-2.

Interpretation
Amine-2388nm (2700-2250nm)
Phenol compound- 3448nm (3550-3200nm)
Alkane- 2851nm (2960-2850nm)

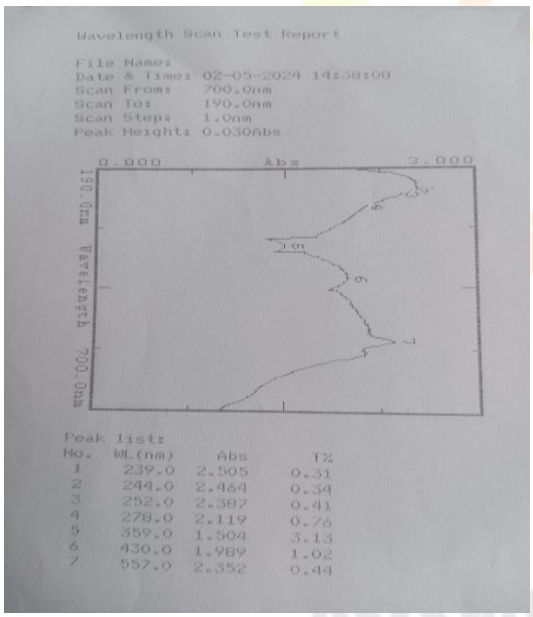


Fig.5a:- UV spectrum of sample-2.

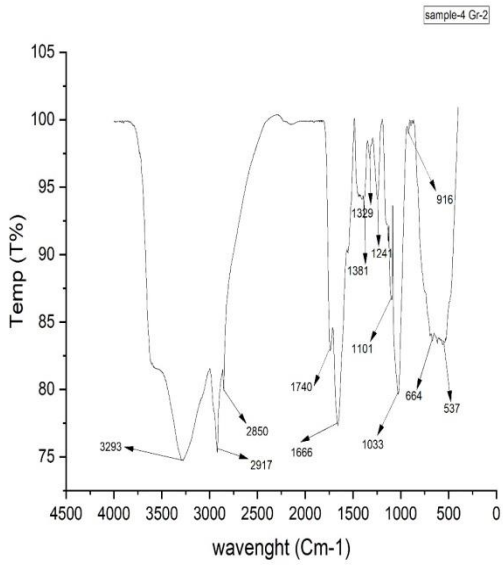


Fig.5b: IR spectrum of sample-2

Interpretation
Phenol compound- 3293nm (3550-3200nm)
Alkane- 2850nm (2960-2850nm)
Aldehyde-1740nm (1740-1720nm)

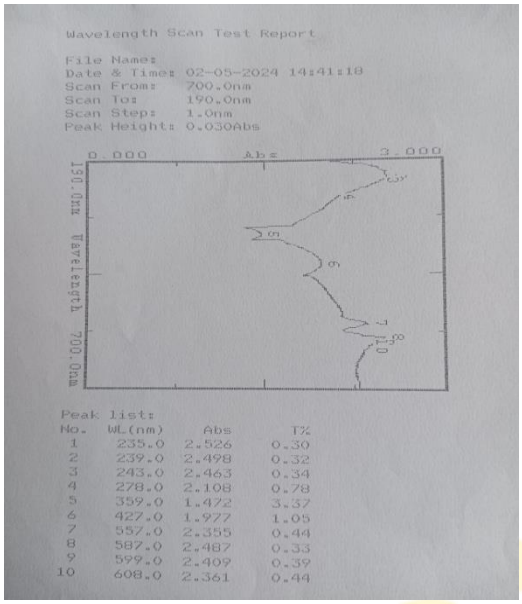


Fig.-6a: UV spectrum of sample-3

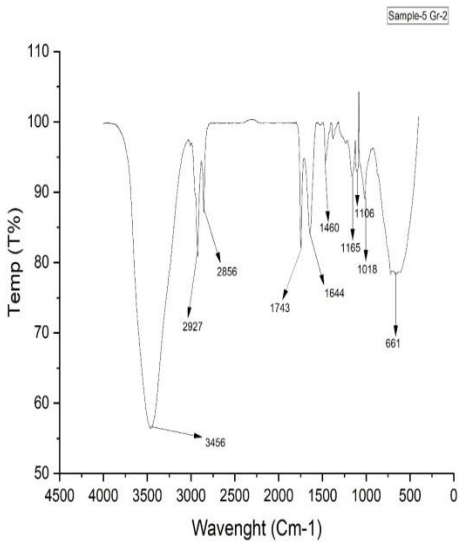


Fig.-6b: IR spectrum of sample-3

Interpretation

The IR spectroscopy of Areca catechu L.

Alcohol-3456nm (3570-3450nm)

Alkane- 2927nm (2960-2850nm)

Alkene-1644nm (1650-1600nm)

Discussion

Sample -1: (Justiciavasculosa (Nees) T. Anderson)

The color obtained in the cotton cloth from this dye without the use of any mordant was dark green. In the aqueous extraction, post mordanting with lead acetate gives khaki brown, with potassium dichromate gives yellowish brown and with ferric chloride gives golden dark brown.

In the UV spectroscopy of the aqueous extraction of the sample, the highest peak was found to be 426nm

Sample-2: (Altenanthera sp.)

The color obtained in the cotton cloth from this dye without the use of any mordant was dark red. In the aqueous extraction, post mordanting with lead acetate gives silver -brown, with potassium dichromate gives dull-brown and with ferric chloride gives gold-brown. In the UV spectroscopy of the aqueous extraction of the sample, the highest peak was found to be 557nm.

Sample-3: (Areca catechu L.)

The color obtained in the cotton cloth from this dye without the use of any mordant was dark red. In the solvent extraction, trans- mordanting with lead acetate gives silver-red, with potassium dichromate gives light golden-brown and with ferric chloride gives dark gold. In the UV spectroscopy of the aqueous extraction of the sample, the highest peak was found to be 608nm.

Conclusion

Based on the above observations and literature survey, natural dyes are to be nontoxic, have calming properties, and economical. They are easily obtainable, renewable, and should not cause harmful effect on environment. The study also revealed that a wide range of colors can be effectively produced by applying natural dyes that are extracted or derived from various plant parts to various materials and fibres. When using natural dyes to dye cotton garments, metal mordants are a must. The type of dye complex that forms throughout the dyeing process determines the color hues that are created. The type of textile material and the mordant employed had a significant impact on how the colors appeared, as well as how strong and stable they were on the cotton materials. One benefit of natural dyeing is the wide variety of colors that may be created by the same dye-yielding plant species when they are treated with different mordants. In order to improve the quality and quantity of natural dye production, it is necessary to gather, evaluate, and characterize plants that yield dyes.

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