Charcterisation of Banana Pseudostem Sap used As a Mordant for Dying

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Banana and banana parts serves as a unique ideal and low cost food source in developing countries. Where most of the populations depend upon for taking cheaper rate nutrition fruits. Banana sap consists of different chemical constituents like carbohydrates, cellulose, lignin, ash, colouring matter and portentous material. These constituents develop through the secondary metabolism of plant contain ISO paranoid, nitrogen and phenolic compounds of plants. In this research study banana pseudo stem sap has been taken for the fixation of natural dye and its chemical composition with qualitative chemical analysis has been observed. The dyeing method like a pilot study with pre mordanting, post mordanting and simultaneous mordanting process is used. In this article main focus on the determination on chemical composition of banana sap has been taken. For the dye fixation banana sap is containing tannin which has great properties for fixation of dye molecules. Natural dyes are well known for their poor fastness properties. So in this study banana sap here used as a mordent. The dyeing results are found quiet appreciable.

Keywords: - *Banana pseudo stem sap, mordent, tannin, lignin, Dye fixation, mordanting process.*

1. INTRODUCTION

Color plays a dominant role in the life of human beings since time immemorial. In the prehistoric times natural colorants were the only source available for imparting color to the life of man. But industrial revolution had cause chemistry to play a predominant role in offering various synthetic dyestuffs to the textile industry and novel techniques of applying them. The advent of synthetic dyes almost limited the use of vegetable dyes for more than a century. The use of synthetic dye stuff during their application release contaminations into the environment, so most of the synthetic dyes belonging to age group and Anthraquinone dyes have been banned by the developed countries. Due to increasing awareness of ecological factors natural dyes are coming in great demand and further scientific developments and inventions are in progress across the globe. So after studying and knowing the importance of banana pseudo stem it has been used for the fixation of color of natural dye extract like palash flower. In this research article firstly determination of chemical composition of banana sap has been observed. In this chemical composition tannin is having beautiful properties for dye fixation. Tannin forms the hydrogen bonds between the phenolic hydroxyl groups of tannins and both the free amino and amido groups of proteins. Tannins are non crystallisable, amorphous compounds their aqueous solution shows an acidic reaction. In this research tannin present in banana sap responsible for dye fixation.

Dyeing from natural dyes has several limitations to gain commercial acceptance. One of the major limitations is fastness properties. To improve this aspect lot of research is being done and it continuous to heart the mind of researcher's mordents is the agents which help to improve the fastness properties.

The pseudo stem water (sap) of banana plant has carbohydrates, lignin, tannin and alpha cellulose, which the current research work is attempting to explore in dyeing to natural fibers by using natural dyes. The dyes extracted from Turmeric, Henna and Catechu, are found to have more compatible for sap as mordant in the preliminary investigation conducted by the author.

2. MORDANTS

A mordant is a substance used to set dyes on fabrics or tissue sections by forming a coordination complex with the dye which then attaches to the fabric or tissue. It may be used for dyeing fabrics, or for intensifying stains in cell or tissue preparations. The term is derived from the Latin *murdered*, to bite. Metal ions of mordant act as electron acceptors for electron donors to form co-ordination bonds with the dye molecule, making them insoluble in water (Mongkholrattanasit *et al.*, 2011). Alum, chrome, stannous chloride, copper sulphate, ferrous sulphate etc. are the commonly used mordants. (Siva, 2007;

Mahangade *et al.*, 2009; Samanta and Agarwal, 2009).The natural dyes which require mordant are called as adjective dyes. Mordants are substances which are used to fix a dye to the fibers. They also improve the take-up quality of the fabric and help improve color and light-fastness. Traditionally, mordents were found in nature. Wood ash or stale urine may have been used as an alkali mordant, and acids could be found in acidic fruits or rhubarb leaves (which contain oxalic acid), for example. Nowadays most natural dyers use chemical mordents such as alum, copper sulphate, iron or chrome.

Mordants are prepared in solution, often with the addition of an 'assistant' which improves the fixing of the mordant to the yarn or fiber. The most commonly used mordant is alum, which is usually used with cream of tartar as an additive or assistant.

3. BANANA PSEUDOSTEM SAP AS MORDANT

In addition to fruit production, huge quantity of biomass (pseudo stem, leaves, suckers etc.) is generated. Presently, this biomass is discarded as waste. In past, some researchers have successfully demonstrated use of banana pseudo stem and leaves for extraction of fibers on a small scale. In India, the fibers are being used for preparing handicrafts, ropes etc., which otherwise can be used for making fabrics, home furnishings and good quality papers.

Banana (Mimosa pudica) is a very common fruit plant in India. Often the banana trunk is thrown away after harvesting the fruit. The waste material is biodegradable. Banana is the common name for herbaceous plants of the *Genus Musa*, and is also the name given to the fruit of these plants.

Pseudo-stem sap has found to contain four amount of nutrient in it. About 15,000-20,000 liters of sap can be extracted from one hectare of Pseudo-stem. Pseudo-stem sap is a thick liquid and very light brown or dusty color.
In this study, this pseudo stem sap which is generally considered as waste has been used as a source of natural mordant (fixing agent for natural dyes).

6. SAMPLE SITE Banana plant pseudo stem sap was collected from Raver Tehsil (Maharastra) just near Burhanpur (M.P.).

7. MATERIALS

7.1 Chemicals and Reagents

Iodine solution, Benedict's reagent, Barfoed's reagent, Seliwanoff's solution, Sulfuric acid, Acetic acid, Acetone, Sodium hydroxide, Fehling's reagent A, Fehling's reagent B, Cotton fabric, Alum, Myrobalan, *Butea* flowers dye, Folin Phenol reagent, Sodium carbonate solution.

7.2 Instrumentation

Hot air oven, Water bath, Desiccators, pH meter, Weighing machine

8. Methods

8.1 Sampling Process

The pointed end of the knife was pushed tangentially into the stem. The incision were left to bleed for 24 h and stored in a wide mouth plastic bottle in refrigerator until use

8.2 Pseudostem sap color:

Pseudostem sap is thick liquid and very light brown or dusty in color.

8.3 Analysis of the composition of the Banana pseudo stems sap:

Qualitative analysis for carbohydrate by Cole's method, (Cole, 1933).

Quantitative analysis of carbohydrate:

8.3.1 Molisch's Test: In a test tube, 2 ml. of the test solution and 2 drops of α-naphthol solution were added. The tube was carefully inclined and conc. H_2SO_4 were poured drop wise, using a dropper, along the sides of the tube. Violet color at the junction of two liquids was observed.

8.3.2 Fehling's Test: In a test tube 2 ml. of the test solution and add equal volumes of Fehling A and Fehling B were added and placed it in a boiling water bath for few minutes. When the content of test tube started boiling, they were mixed together and observed for any change in color or precipitate formation. The production of yellow or brownish – red precipitate of cuprous oxide indicated the presence of reducing sugars in the given sample.

8.3.3 Benedict's test: To 2 ml. of Benedict's regent, 5 drops of the test solution were added and mixed well. The test tube were placed in a boiling water bath for 5 minutes after that the solution were cooled and observed for any change in color or precipitate formation. The color change from blue to green, yellow, orange or red (depending upon the amount of reducing sugar present in test sample) were observed.

8.3.4 Barfoed's Test: To 2 ml. of the test solution about 2 ml. Barfoed's reagents were added. Mixed bath. The solution was allowed to stand for few minutes. Formation of a red precipitate of cuprous oxide in the bottom and along the sides of the test

8.3.5 Iodine Test: 2 drops of iodine solution were added to about 2 ml. of the test solution. A blue black color was observed which is indicative of presence of polysaccharides.

. tube immediately, indicated the presence of monosaccharide. Since Barfoed's reagent is weakly acidic, it is reduce only by monosaccharides.

8.3.6 Seliwanoff's Test: To 2 ml. of Seliwanoff's reagent, two drops of test solution were added and mixture was heated to just boiling. A Cherry red

well and boiled for one minute in the water

tube immediately, indicated the presence of monosaccharide. Since Barfoed's reagent is weakly acidic, it is reduce only by monosaccharides.

8.3.7 Ph test: Banana pseudo stem sap ph are lies between 7 -8

condensation product was observed indicating the presence of ketoses in the test sample.

9. Chemical analysis

9.1 Sample preparation:

A petri plate previously cleaned and dried in an oven was weighed on an analytical balance to 0.01 g. 30 gm of banana pseudo stem sap was placed on the Petri plate. The sap was dried in oven at 60°C for 24

hours with the cover off. Then the Petri plate was removed and placed in the desiccators for 15 minutes to cool, before weighing. Procedure is referred from TAPPI Standard.

9.2 Determination of Holocellulose content (TAPPI Standard T 222os – 74):

2 g of air dried sawdust was weighed accurately. The sawdust was transferred quantitatively to a 250 ml conical flask. 100 ml water, 1.5g sodium chloride and 5 ml of 10% acetic acid were added and the flask was placed in a water bath maintained at 70°C, swirling the content of the flask at least once every five minutes. The flask was kept closed with a small, inverted Erlenmeyer flask. 5 ml of 10% acetic acid was added after 30 minutes. 1.5g sodium chloride was added after further 30 minutes. Alternative acetic acid and sodium chloride at 30 minutes were continued, after last addition of sodium chloride. The mixture was heated for 30 minutes after last addition of sodium chloride. The suspension was cooled in an ice bath. Residue was filtered into a weighed fruited glass crucible (medium or coarse porosity) and washed with iced distilled water and finally washed with acetone. The residue was air-dried (allowed the residue to strand in the open laboratory for a day or

$$= \frac{W_4 - W_3}{100 \times W_2} \times (100 - W_1)$$

two until it is free of acetone) Covered it with a perforated aluminum foil. The sample was transferred to desiccators and weighed at daily intervals until the sample reached constant weight. The moisture content was determined on a 0.5 g sample which is afterward.

The following formula was used to determine the holocellulose content in pseudo stem:

9.3 Determination of Cellulose content (TAPPI Standard T203 om- 93):

Weigh 1 gm of a holocellulose sample and placed in 200 ml beaker. Add 25 ml of 17.5% sodium hydroxide and stir. After 4 minutes, smash for 5

Holocellulose content in pseudo stem sap (percent)

Where,

W_1 = extractive free content (percent)
W_2 = weight of oven- dried extractive free sample (grams)
W_3 = weight of oven dried crucible (grams)
W_4= weight of oven- dried residue and crucible (grams)

α-cellulose content in pseudo stems sap (percent)

minutes. After 16 minutes, add 25 ml of distilled water and stir for 1 minute. After 5 minutes, filter with a pre weighed glass filtering crucible and wash with distilled water until neutral. Add 40 ml of 10% acetic acid and hold for 5 minutes.

Weigh the residue to calculate the α-cellulose content.

Where,

$$= \frac{W_4 - W_3}{100 \times W_2} \times W_1$$

W_1 = Holocellulose content (percent).
W_2 = weight of oven- dried holocellulose sample (grams).
W_3 = weight of oven dried crucible (grams).
W_4 = weight of oven dried residue and crucible (grams).

9.4 Determination of Hemicellulose:

Hemicellulose was calculated by subtracting cellulose from holocellulose.

Hemicellulose content in banana pseudo stem sap (percent) = $P_1 - P_2$
Where,

$$= \frac{W_4 - W_3}{100 \times W_2} \times (100 - W_1)$$

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Lignin content in Banana pseudostem sap (percent)

9.6 Tannin content:

The tannins were determined by Folin and Ciocalteu method. 0.1 ml of the sample extract was absorbance was measured at 725 nm. Blank was prepared with water instead of the sample. A set of standard solutions of Gallic acid is treated in the same manner as described earlier and read against a blank.

10. Dyeing procedure

Table 1

Solvent	Temperature (°C)	Time (minutes)
Distilled water	80-85	90

CONDITION FOR EXTRACTION OF NATURAL DYE

P_1= Holocellulose content (percent)
P_2 = Cellulose content (percent)

9.5 Determination of Lignin content (TAPPI standard T 222 om – 06):

2 grams of sawdust was weighed out accurately in weighing bottle and transferred in a 100 ml beaker. 40 ml of cold (10-15 °C) 72% sulphuric acids was added carefully with a pipette and the mixture was stirred with a small glass rod. After the specimen is dispersed, cover the beaker with watch glass and keep it in a bath at 20 °C for 2 hours. Stir the materials frequently during this time to ensure complete solution. Add about 300 to 400 ml of water to a flask and transfer to material from the beaker to the flask. Rinse and dilute with water to 3% concentration of sulfuric acid, to a total volume of 1540 ml. Boil The solution for 4 hours, maintaining constant volume by addition of hot water. Allow the insoluble material (lignin) to settle keeping the flask in an inclined position. Without stirring up the precipitate, decant or siphon off the supernatant solution through a filtering crucible. Wash the lignin with hot water. Dry the crucible with lignin in an oven at 105°C to the constant weight. Cooled in a desiccators and weighed where,

W_1 = extractive free content (percent).
W_2 = Weight of oven dried extractive- free sample (grams).
W_3 = weight of oven dried crucible (grams).
W_4 = weight of oven dried residue and crucible (grams).

10.1 Fabric sample

Pure cotton fabric with plain weave is used. The fabric sample is used with 2 gm owf (oven weight of fabric)

10.2 Dye extraction

In this method, dye from flowers powder were extracted by preparing an aqueous solution of flowers (10 g in 100 ml distilled water) and the extraction process was carried out at a temperature range of 80-85°C for 90 minutes. Extract was then filtered through a piece of cloth to yield the natural dye.

10.3 Pre-treatment

Harra (*Terminalia chebula* L.) powder is used for pre-treatment. Commercial Harra powder was purchased from the local market. For this 30 gms. of Harra powder in 3 lit. water, is boiled for 20 min. along with the fabric sample. The fabric samples were taken out and dried. Pre-treatment is given to half the number of samples.

10.4 Biomordanting

The cotton fabric were mordanted using different amounts of banana pseudo stem sap as mordant solution (10, 20, 30, 40 and 50 % owf) at 80 °C and M:L= 1:30 for 90 minute

I. Pre-mordanting:

In this method, 5 cotton samples were pretreated with the Banana sap with different concentration 10, 20, 30, 40 and 50 % for 90 minutes at 80° C. The pretreated cotton fabric was introduced into the dye bath containing required amount of dye extract and water. The dyeing was carried out for 90 minutes at 80℃. The dyed samples were taken out, squeezed and dried at room temperature.

II. **Simultaneous Mordanting:** Simultaneous Mordanting was done with the help of method in which , the 5 cotton samples were dyed with dye extract as well as the Banana sap with different percent 10, 20, 30, 40 and 50 % for 90 minutes at 80° c simultaneously. The dyed samples were taken out, squeezed and dried at room temperature.

TABLE 2
CONDITION FOR DYEING

Fabric	Mordant concentration	Dye concentration	Temperature (°C)	Time (min)	M:L ratio
Cotton	10%	20%	80°C	90	1:30
	20%				
	30%				
	40%				
	50%				

III. **Post Mordanting:** 5 cotton fabrics was introduced into the dye bath containing required amount of dye extract and water for post mordanting method. The dyeing was carried out for90 minutes at 80℃. The dyed samples were taken out, squeezed and treated with the Banana sap with different percent 10, 20, 30, 40 and 50 % for 90 minutes at 80° C.

10.5 After treatment: Alum is used for after - treatment. For this 10 gms. of alum in 200 ml water. For 90 minutes at 80℃ on water bath along with the fabric sample. The fabric samples were taken out and dried.

10.6 Fastness properties: The fastness of dyed sample was evaluated according to standard methods. All the samples, pretreated and without–pretreated, after treatment and mordanted were measured**. (The fastness property of the dyed sample will be explained in the next paper.)**

12. Results

Table 3

Qualitative tests used for carbohydrate analysis

No	Test	Observation	Inference
1	**Molisch's test**	Positive	Presence of carbohydrates
2	**Iodine test**	Negative	Absence of Starch
3	**Fehlings test**	Positive	Presence of reducing sugars
4	**Benedict's test**	Negative	Absence of reducing sugars
5	**Barfoed's test**	Positive	Presence of reducing sugars
6	**Seliwanoff's test**	Positive	Presence of ketose Presence of aldoses

The carbohydrate analysis test was shown positive results for presence of reducing sugars

Table 4
Chemical composition of banana pseudo stems sap

Content	Value (%)
Holocellulose	5.51%
Hemicelluloses	5.424%
Cellulose	0.086%
Lignin	1.44%
Tannin	4.06%

In table 4 Chemical composition of banana pseudo stem sap was analyzed and different contents calculated in percent basis. Holocellulose, hemicellulose, cellulose, lignin were foundout Tannin were main contents in banana pseudo stem sap which was used as a mordant in dying process. Holocellulose includes alpha cellulose and hemicellulose. Cellulose content in banana pseudo stem sap was very low. Cellulose is a homopolysaccharide composed of β-D-glucopyranose units which are linked together by (1→4)-glycosidic bonds. Cellulose molecules are completely linear and have a strong tendency to form intra- and intermolecular hydrogen bonds.

Hemicelluloses are heterogeneous polysaccharides, like cellulose, most hemicelluloses function as supporting materials in the cell walls [Sjostrom 1981].

However banana pseudo stem sap had lower lignin i.e. 1.44% content than wood but its glue like quality is important for dyeing process.

Banana pseudo stem sap has 2.06% of tannin. Tannin is defined as naturally occurring water soluble polyphenolic compounds of high molecular weight (about 500-3000) containing phenolic hydroxyl groups to enable them to form effective crosslink between proteins and other macromolecules.

13. Discussion

1. Chemical compositions confirm the presence of following contents on percent basis in banana pseudo stem sap. They are holocellulose, hemicelllulose, cellulose, lignin and tannin. Tannin is the most important ingredients which are the most important ingredients which are necessary for mordanting with natural dyes.
2. In banana pseudo stem sap it has been confirmed by laboratory research work that tannin content is present in banana sap mordant. Cotton is less suitable for natural dyes. There are some natural dyes that was work on cotton, however especially if mordanted with tannins. Cotton is the second most consumed fiber worldwide, after polyester. Cotton dyeing with *Butea* flowers gave various shades with different concentration of banana pseudo stem sap. *Butea* flowers yield and orange dye which is used to prepare traditional color in Holi festival from ancient time..

When we introduced sample in after treatment with alum, its enhance the color fastness of samples. After treatment with alum also gave various shades on cotton.

Sample treated with harra (*Terminalia chebula*) improve the washing fastness of the dye. Harra is a good source of tannin acid and chebulic acid. Cotton fabric have been reported to be pretreated with tannin acid that provide carboxylic acid (-COOH) groups to the fabric.

14. CONCLUSION

1. In banana crop, after harvesting the bare pseudo stem remains in several tons as a waste. Fiber can be produced for paper industry, fabrics or yarn industry etc. But usually they are disposed of by burning in fields which creates another air pollution problem. Larger amount of solid waste increases pollution load in environment.
2. In this connection, present study deals with the use of banana pseudo stem sap as a mordant to utilize a large quantity of biomass. The remaining material can be used as fiber, green manure, as a source of carbohydrate for production of starch, sugar and alcohol.
3. Synthetic mordents cause many health hazards in society due to irruption of problems like skin and eye irritation, inflammation, more damage to wounds and abrasions, possibility to enter in blood stream etc.To encounter these above problems, studies were carried out to use of pseudo stem sap in ecofriendly manner and reduction in pollution load from environment. Enormous use of synthetic dyes is so common because of high demand in fabric and textile industries. Studies show that synthetic dyes are in use since 1856. Now a days people are shifting towards the natural dyes due to hazardous effects of chemical dyes.

The process of extraction of banana pseudo stem sap and its use as a mordant was found to be cost effective as compared to the cost of chemical mordents in local market.

If above concern has become fruitful it will give a way to grow more plants for greater use of dyes and mordents in textile industries, which will help to solve the problem of unemployment.

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