Extraction of eco-friendly natural dye from *Hibiscus acetosella* flowers for dyeing cotton fabric using natural mordant and its effect on pH-values

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Abstract-Current study revealed about the dyeing properties of *Hibiscus acetosella* on cotton fabrics using natural mordant. The plant *Hibiscus acetosella,* often known as African Rose mallow or Cranberry Hibiscus, is a member of the Malvaceae family. *Hibiscus acetosella* typically produces crimson or pinkish-red flowers. Dyes are extracted from *Hibiscus acetosella* flowers, producing a natural colorant. The dyeing pigments present in *Hibiscus acetosella* were extracted in this work by use of the aqueous extraction method, which required a 15-minute immersion in water and extracted dye was used to dyeing cotton fabrics without a natural mordant, and three fractions extracted were taken to observe the impact of three distinct mordanting techniques: pre, post, and simultaneous mordanting. The cotton cloth was soaked in a bath of boiling water with the coloring solution for five minutes. Following dyeing, the pH of the remaining sample was once more measured with a pH meter, and pH fluctuations were documented.

Keywords: *Hibiscus acetosella*, Natural mordant, Cotton fabrics, Natural dye.

Introduction

Since ancient times, coloured clothes have been used. In order to colour these clothes, natural dyes were used. Even synthetic dyes were also available to colour them but natural dyes were always been better to use and to dispose as well. Natural dyes are environment-friendly and do not produce toxic substances because they are all made up of roots, leaves or flowers. Although clothes have been coloured with natural dyes since ages, synthetic dyes have already taken their place. Synthetic dyes have many disadvantages such as disposal of waste, but

still they are used in the industrial and textile sectors.

Although synthetic dyes provide diversity in colours, it expressed worries due to their environmental and health effects. They also pollute water as heavy metals or chemical can leach into water bodies. During the production of synthetic dyes if humans are exposed to harmful chemicals and dyes it leads to respiratory issues, skin irritation, allergic reactions etc. Both biodegradability and sustainability are missing in synthetic dyes. Because of this circumstance, natural dyes are selected as a suitable substitute, even though we are aware of their lack of economic success. Natural dyes[1,2] are beneficial as they are biodegradable[3] and are less harmful to nature, do not release toxic substances in water bodies, depends on renewable resources lowering reliance on fossil fuels and lessening the damage that resources extraction causes to environment, and require less energy and reduce the amount of greenhouse gases emissions.

After the industrialisation era, there is a major trend in the increase of pollution in the world. A major cause for the increase of pollution could be the use of synthetic chemicals and products. Therefore, there emerges the need for using alternative to these synthetic products that would cause lower or no harm to the environment. As awareness is increasing about the negative consequences of these synthetic products, the market for natural goods has expanded. Natural dyes can be used in place of multiple artificial colours used in textile manufacturing. This modification will encourage the sustainability[4,5,6] and ecological substitute for synthetic colours and hence providing the advantage for human health as well as environment. This will also encourage the future generation towards the use of natural resources[7,8] and encouraging healthy planet. Nowadays, the trend for the natural dyes has certainly grown up in India[9] because the people are becoming more and more conscious about the harmful effects of synthetic chemicals. The synthetic dyes are really harmful since they contain toxic substances and heavy metals which make them very difficult to dispose. Sustainable livelihoods are additionally promoted via promoting the use of natural dyes. But we know that the synthetic dyes are much better in terms of stability and colour fastness, hence the research is conducted continuously in order to satisfy customer expectations and their standards. It's not like the natural dyes only used for garments, they are used for a variety of purposes like household textiles, industrial uses and a lot more.

A process called "mordanting" is used to add mordants to fabric, which serves as a

binding agent for attaching the dyes to the cloth. Three different forms of mordanting processes exist: Pre-mordanting, Post-mordanting and Simultaneous mordanting. The process of Pre - mordanting involves treating the cloth with mordant before dyeing it. After that fabric is dried after being dipped in the dyeing solution. In Simultaneous mordanting the dye- bath receives a direct addition of mordant. In Post-mordanting before the fabric gets soaked in the mordant solution, it is dyed by dipping in a dyeing solution. Mordanting is needed in dyeing process for the fixation of dyes to ensure that they do not easily wash out or fade over time, to improve colourfastness means colour remain bright and oppose fading when exposed to light, washing etc.

Botanical Description of *Hibiscus acetosella*

Hibiscus acetosella[10] is a member of family Malvaceae. The petals of the *Hibiscus Acetosella* flower are either purple or crimson in color. It grows to height of 3-6 feet. *Hibiscus Acetosella* develops a fruit that mimics a capsule and is filled with number of seeds.

Chemical composition of *Hibiscus acetosella*

It contain anthocyanins which is responsible for its red or purple colour, flavonoids, phenolic compounds[11,12] such as Quercetin, Myricetin, Kaempferol etc. (Figure. 1). which contributes to dyeing properties on fabrics and antioxidant properties, vitamins such as Vitamin-C, minerals including calcium, iron, magnesium and potassium, organic acids such as citric and malic acid

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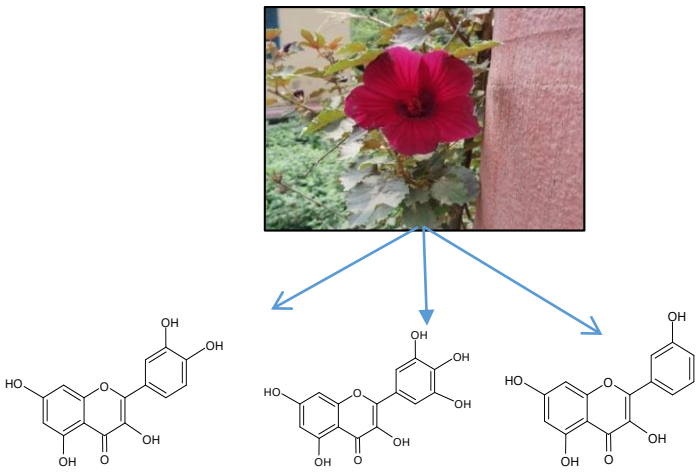

Quercetin Myricetin Kaempferol

Figure-1 A flower of *Hibiscus acetosella* and three major colour constituents

Uses of *Hibiscus acetosella*

Plants of *Hibiscus acetosella* are leafy vegetables with leaves and young roots as their edible parts and can be used for various gastrointestinal problems as it contains anti-inflammatory properties due to the presence of flavonoids and phenolic acids. This species can also be used to lower down blood pressure and possesses antioxidant properties to reduce oxidative stress.

Importance of *Hibiscus acetosella* as a natural dye bearing plant

Synthetic dyes are not at all environment friendly because they produce a number of toxic substances which are harmful to the environment both at production and disposal level. Since *Hibiscus acetosella*'s dye is a natural dye, it can be safely disposed and is easily biodegradable. In cultural practices it was used to dye clothes or to paint. Because *Hibiscus acetosella* natural dyes are non-toxic, they degrade quickly in the environment. They do not cause allergies or skin rashes and are safe for the skin. Colours obtained from *Hibiscus acetosella* come in number of varieties and textures. Different colour can be made based on the pH and mordant used. The antioxidant properties and bioactive compounds of alternative edible flowers of *Hibiscus acetosella*. The flower's extracts have phenolic composition and shows scavenging activity of free radicals. The flowers contain moisture content, carbohydrates, lipids, ashes, not detectable protein and have pH of 2.8. Because bioactive compounds have no cytotoxicity and have nutraceutical potential, they are relevant in healthy diet. Studies have indicated that flower extract of *Hibiscus acetosella* may be an important natural bioactive ingredient for usage in food supplements and beauty products. For the stability of bioactive compounds from *Hibiscus acetosella*, the low temperature during freeze-drying resulting in better retention of active constituents. Previously it has been reported that this species was responsible to the treatment of anaemia and has anti-anaemic properties. *Hibiscus acetosella* is a dye bearing plant with high colour potential to dyeing the fabrics including with or without mordanting methods and mordants.

Material and Methods

Material

- Flowers of *Hibiscus acetosella* were collected from college campus.
- Cotton fabrics for dyeing
- Lemon juice as natural mordant
- A pH meter

Methods

Cotton fabric dyeing is done in five steps:

1. Dye extraction from flowers
2. Scouring
3. Without mordanting
4. Mordanting and Dyeing
5. Drying

First fresh flowers of *Hibiscus acetosella* were collected (Figure-2) and then petals are dried under the shade (Figure. 3). After drying, petals are crushed to get the powder form (Figure-4)

Figure-2

Figure-3

Figure-4

Natural dye Extraction

Aqueous extraction method- 10gm of powdered form was soaked in 250ml distilled water and then kept it on a water bath and boiled it for 15 minutes. Then allowed it to cooled, finally filtered. The 200ml of the extracted material that was obtained after filtering is used for colouring. Divided the 200ml solution in four equal parts i.e., 50 ml each for Pre, Post, Simultaneous mordanting and without mordanting (Figure-5).

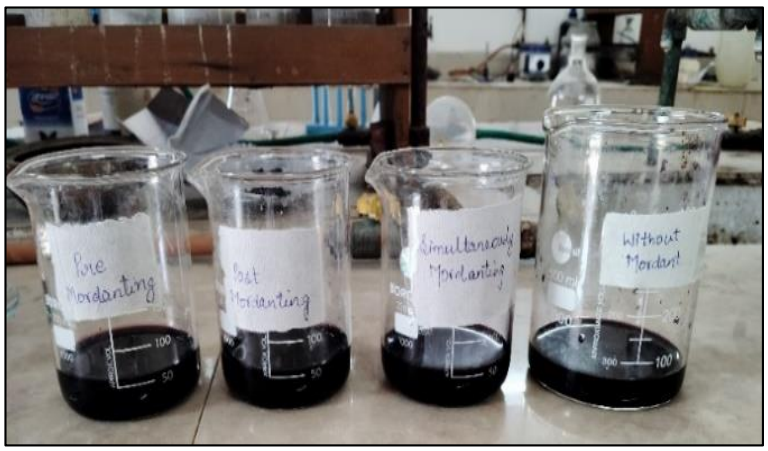

Figure-5 Four equal parts of 200ml solution for pre, post and simultaneous mordanting with natural mordant and without mordantin

Scouring of Cotton fabric- Cotton fabric was boiled in water to remove the impurities and washed with cold distilled water (Figure-6)

Figure-6 Clean cotton scouring fabric

Mordanting

Mordanting is a process of adding mordants to fabric. Mordant acts as a binding agent for fixing dye to the fabric. There are three different methods of mordanting:

(a) Pre – Mordanting: In Pre – Mordanting first cloth is dipped in a mordant solution then mordant containing cloth is transferred in a dyeing solution.

(b) Post – Mordanting: In Post – Mordanting first cloth is dyed by dipping in a dyeing solution and then treated with mordant solution.

(c) Simultaneous Mordanting: In Simultaneous Mordanting mordant solution is added to dyeing solution.

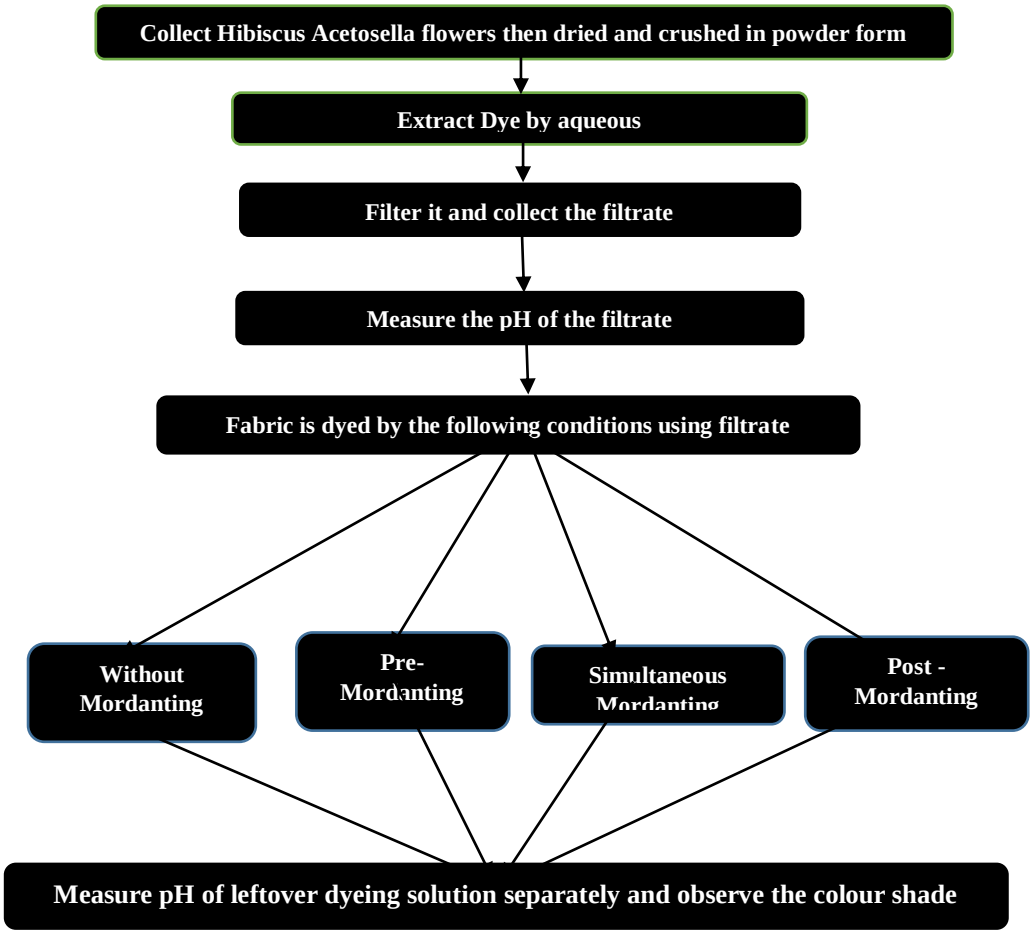

Figure-7 A scheme for extraction, dyeing and mordanting

Results and Discussion

The observed results are as follows:

- **Without Mordanting-** The Cotton Fabric is soaked in 50 ml dyeing solution and kept on boiling water bath for 5 minutes. Then cotton fabric is removed and pH is noted of leftover dyeing solution.
- **Mordanting with a natural mordant and Dyeing-** Mordant acts as binding agents i.e., used for fixing the dye on the fabric. 2ml Lemon juice was mixed with 10 ml water for Pre - Mordanting, and same mixture is prepared for other two methods also. This is a mordant solution.
  - **(a) Pre-Mordanting:** First clean cotton scouring fabric is soaked in a mordant solution and then transfer the mordant containing cotton fabric in another dyeing solution of 50 ml. Keep the dyeing solution on boiling water bath for 5 minutes. Then the pH was noted of leftover dyeing solution.

(b) Post-Mordanting- First clean cotton scouring fabric is soaked in a dyeing solution of another 50 ml and kept the dyeing solution containing fabric on boiling water bath for 5 minutes. After that, the cloth is taken out of the dyeing solution and dipped in a mordant solution and pH of the remaining dyeing solution was measured.

(c) Simultaneous Mordanting: Mordant was added to another 50 ml dyeing solution and then the solution is divided into two parts. The pH of one part is noted i.e., before the dyeing. The Cotton fabric is soaked in other part of solution and solution is kept on a boiling water bath for 5 minutes. Then fabric is removed from dyeing-mordant solution and pH of leftover dyeing-mordant solution is noted i.e., after dyeing.

Figure: 8- Leftover dyeing solution after dyeing in each case

- **Drying-** The dyed cotton fabric is dried at room temperature.
- Variations in pH with respect to before dyeing and after dyeing with few mordanting conditions:

Table 1. Variations in pH values w.r.t. before and after dyeing the fabrics

S. No.	Conditions	pH before dyeing	pH after dyeing
1	Without mordant/After dye extraction	4.65	4.90
2	Pre-Mordanting		4.47
3	Post-Mordanting		4.93
4	Simultaneous Mordanting	4.02	3.98

The different shades of color were obtained from Pre- mordanting, Post-mordanting, and Simultaneous mordanting or without any Mordant. The variations in color in each case are given below:

Table 2. Variations in colour shades with and without natural mordant under Pre-mordanting, Post- mordanting, and Simultaneous mordanting

S. No.	Mordanting conditions	Dyed fabric without natural mordant	Dyed fabric with natural mordant	Colour Shades obtained
1.	Pre-Mordanting	 (Dark purple in colour)		Bleached cedar
2.	Post-Mordanting			Wine berry
3.	Simultaneous Mordanting			Old Mauve

Conclusion

From the current study, it was concluded that the cotton fabric can be dyed with extract from *Hibiscus acetosella* flowers to achieve a variety of colour tones, either with or without the use of a natural mordant like lemon juice. pH variations are seen when various mordanting techniques, such as simultaneous, post-, and pre-mordanting, were used. When cotton cloth is dyed without the use of a mordant, the pH value varies as well. People are becoming more conscious of the negative consequences of synthetic colours and are increasingly worried about both the environment and their own health. This will incentivize the next generation to preserve the environment and public health by using natural dyes rather than synthetic ones. As a result, more plants of this species will be planted in order to provide natural dyes that are good for both the environment and people.

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Disclaimer Statement

Authors declare that no competing interest exists. The products used for this research are commonly used products in research. There is no conflict of interest between authors and producers of the product.

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