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Exploration of plant derived natural dyes in Assam

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■ **ABSTRACT :** Considering the importance of natural dyes, a survey to explore plant derived natural dyes was conducted during 2012-13 in different locations of Jorhat district of Assam. Altogether six sources of natural dyes *viz.*, *Tectona grandis* (teak), *Nyctanthes arbor-tristis* (night-flowering jasmine), *Lawsonia inermis* (henna), *Tagetes patula* (marigold), *Clitoria ternatea* (aparajita), *Curcuma longa* (turmeric) and *Phutuki* (*Melastoma malabathricum* L) were explored. Alum (Potassium aluminium sulphate), Copper sulphate, vinegar and ammonia were used as mordants. Experimental results indicated that varieties of colours can be produced from a single plant depending on the types of mordant used. The treated fabrics showed excellent colour fastness properties. The treated samples did not exhibit any colour fading and maintained the original texture. Antibacterial activities of raw and the mordanted dye samples against both *E. coli* and *S. aureus* bacteria were examined. The antibacterial activity of dyed fabrics was ranked as copper sulphate > potassium aluminum sulphate > vinegar > without mordant against both *S. aureus* and *E. coli*. The technique of producing natural dyes from the aforementioned sources was percolated and popularized among the local self-help groups of Jorhat, Assam.

■ **KEY WORDS:** Exploration of plant, Natural dyes, Mordant

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Assam is one of the biodiversity hotspots that occupies a special place in North East India which is located between $24^0 44^/$ N to $27^0 45^/$ N latitude and $89^0 41^/$ E to $96^0 02^/$ E longitude covering 2.4 per cent of total geographical area. Favourable geographical location, diversified topography and ideal climatic conditions have made Assam very rich in biodiversity. The vegetation of Assam is primarily of tropical type covering areas of evergreen, semi-evergreen, grasslands, deciduous forests, grasslands and riverside forests. Scientific approach for their exploration, utilization, conservation and value addition may be the key points for entrepreneurship development by exploiting the indigenous technology knowledge. Exploring sustainable technique on natural dye extraction from native plants for textile industry is gaining popularity all over the world during the last decade. Natural dyes are easily available and environment friendly. The interest in natural dyes is growing and these are being perceived to provide an environment-friendly dyed fabrics and garments. Natural dyes and colorants are still an essential part of the world's ecological and cultural heritage. With an increased interest in sustainability, there appears to be a changing cultural landscape towards natural dyes since many of the industrialised nations are advocating for natural (green) products and sustainable ways of living. Historically many dye plants were once regarded to possess 'magical properties' with the power to heal and to keep evil away (Balfour-Paul, 1998). Today many of these plants that can be used for dye extraction are classified as medicinal plants because of their remarkable anti-microbial properties (Gupta *et al.,* 2004). Natural dyes are believed to be safe because of their nontoxic, nonallergic and biodegradable nature (Mirjalili *et al.,* 2011). Many plants and some animals have been identified as potentially rich in natural dye contents and some of them have been used for natural dyeing for quite some time. Various parts of plants like roots, stems, leaves, flowers, fruits of various plants, dried bodies of certain insects and minerals are used as natural dye. The shade of

the colour a plant produces will vary according to time of the year the plant is picked, how it was grown, soil conditions etc. (Vankar Shanker, 2009). Henna (*Lawsonia inermis*) has been used as a colorant for over three thousand years and was often mixed into a paste and used to colour skin and hair. It is still widely used in cosmetology for its dyeing properties. It is also proven to have antifungal and antibacterial properties and turmeric (*Curcuma longa*) has been used as an environment friendly colouring substance for both food and cloth for centuries. It is the brightest of naturally occurring yellow dyes although a rather fugitive and has been recognised as a powerful antiseptic, which revitalises and rejuvenates the skin (Kate, 2013). Furthermore, many natural dyes are enhanced by and made more permanent with the use of mordants. Mordants are metallic salts that are used in natural dyeing to help set the dye pigment and improve colour and light fastness. Different mordants give different hue colour with the same dye. Considering the huge scope of natural dyes, the present investigation was undertaken to explore and popularize plant derived natural dyes in Jorhat district of Assam.

■ RESEARCH METHODS

The study was conducted under the agies of Home Science component of Krishi Vigyan Kendra, Jorhat, Assam Agricultural University in 2012-13. Altogether seven sources of natural dyes *viz.*, *Tectona grandis* (teak), *Nyctanthes arbor-tristis* (night-flowering jasmine), *Lawsonia inermis* (henna), *Tagetes patula* (marigold), *Clitoria ternatea* (aparajita), *Curcuma longa* (turmeric), Phutuki (*Melastoma malabathricum* L.) were selected.

Dyeing procedure:

Cotton fabric and wool were dyed by the extracted dye with mordant and without mordant. Dyes were extracted by boiling leaves (teak, henna), flowers (night-flowering jasmine, marigold, aparajita), seeds (*Phutuka*) and roots (turmeric) for half an hour. The crude dyes were strained after proper extraction of colour. Then simultaneous mordanting (where mordant and dye were mixed together and applied) was carried out for 45 minutes to dye the white cotton fabric pieces (25 x 25 cm) and white wool. Cotton fabric and wool were dyed separately.

Mordant when combined with different natural dyes can make varieties of colours. Perusal of Table A describes the detail process of preparing mordants before dyeing. Before removing from stove fixer was used and boiled for 10 minutes (Amla and *Silikha* juice was used as natural sources) and removed from stove. Then fabric pieces and wool were rinsed with cold, clean water and dried out in shadow and stored in steel wardrobe. Antibacterial activity of crude and mordanted dye against Gram-positive bacteria (*S. aureus*) and Gram-negative bacteria (*E. coli*) was tested as per the standard method.

■ RESEARCH FINDINGS AND DISCUSSION

It was ascertained that the knowledge regarding natural dye was found to be very limited among the trainees during pre-test but after demonstration it was significantly increased during the post-test.

Perusal of Fig.1-3 vividly showed the attractive dying properties of seven indigenous plants of Assam. The crude dye obtained from the selected plants produced different colour, shades when treated with and without mordants. *Phutuki* seeds have produced shades of purple, teak leaves produce shades of pink, *Aparajita* flower produces shades of blue, night jasmine flower produces shades of brown, marigold flower produces shades of yellow, henna showed greenish brown and turmeric produces shades of yellow.

More or similar observations on effect of natural dyes were also reported by Wipplinger (2004), that alum seemed to be the best mordant, in that it went through a pre-soaking process and was not added directly to the dye bath, which is the case for the other mordants.

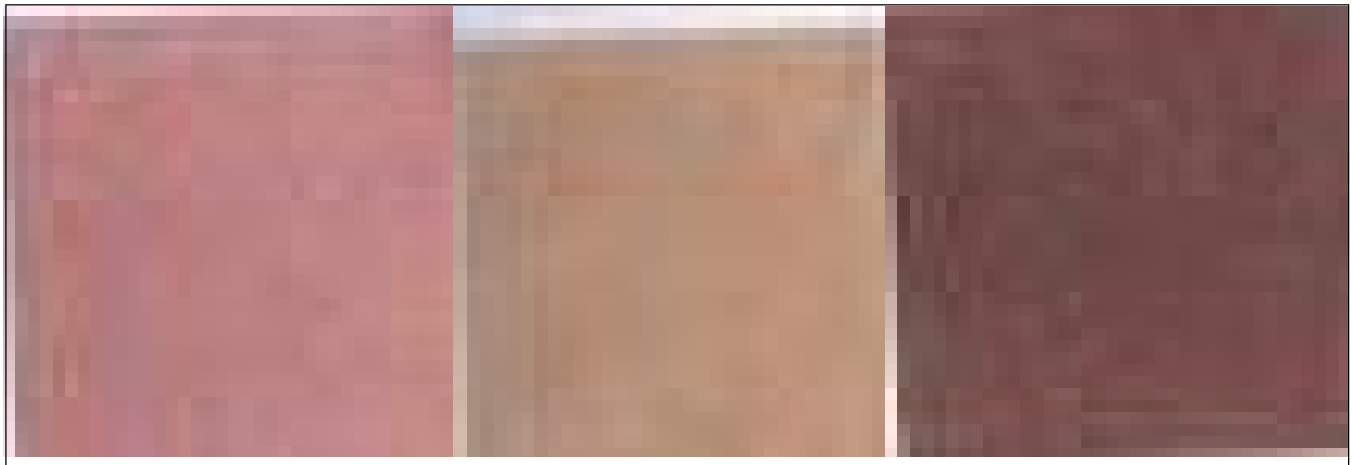
Antibacterial activities of raw and the mordanted dye samples against both *E. coli* and *S. aureus* bacteria were examined. *S. aureus* bacterium is a pathogenic micro-organism causing many illnesses such as purulence, toxic shock, fibrin coagulation, endocarditic and abscess. Furthermore, it is resistant to common antibacterial agents (Dastjerdi *et al.*, 2009). Moreover, *E. coli* bacterium that causes wound infections and urinary tract is a popular test organism (Montazer *et al.*, 2011). It is reported that the mordanted dyed fabrics have higher antibacterial properties in comparison with raw samples. The antibacterial activity of dyed fabrics was ranked as copper sulphate > potassium aluminum sulphate > vinegar > without mordant against both *S. aureus* and *E. coli*. Based on the obtained results, specimens showed better efficiency against *E. coli* in comparison with *S. aureus*. This can be explained by the

Table A: Details of preparation of mordant

Mordants	Measurement	Amount of water or dye	Mordant observations
Alum (Potassium aluminium sulphate)	3.5 g	200 ml	Alum: small white crystals
Copper sulphate	0.1 g	40 ml of dye	Light blue powder
Vinegar	2.5 ml	30 ml of dye	Clear liquid with a sour smell
Ammonia	1 ml with 2 ml of water	30 ml of dye	Clear liquid

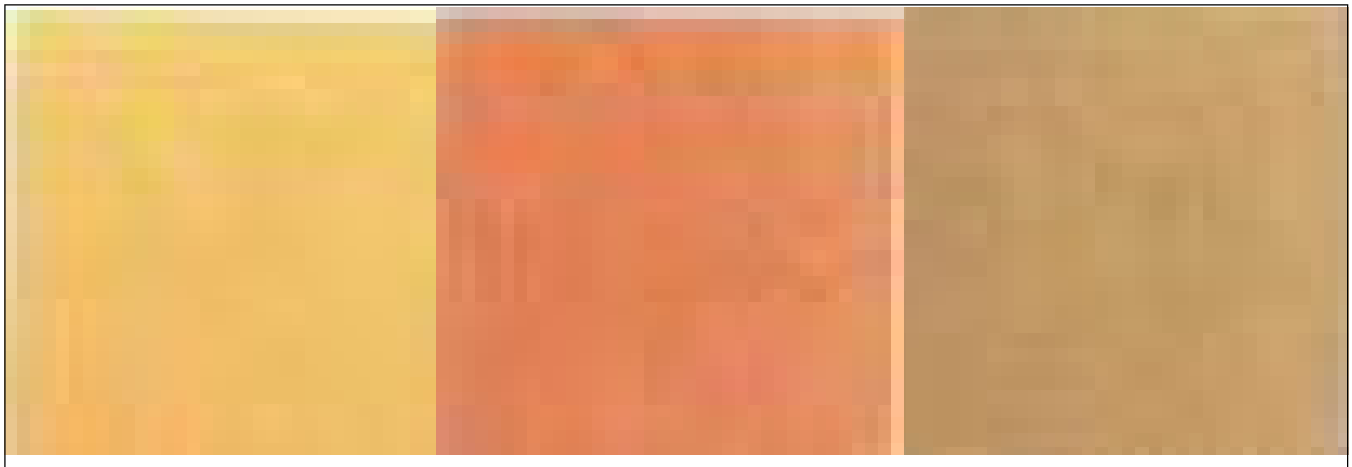
Dye source	No mordant	Alum mordant
Phutuka seeds	Light purple	Dark purple
Teak leaves	Pink	Dark pink
Aparajita flower	Lavender	Purple
Night jasmine flower	Yellow	Brown
Marigold flower	Yellow	Brown

Fig. 1: Effect of different mordants on dye colour producing different shades



A. **B.** **C.**

Fig. 2 : Shades obtained with henna treatment with (A) no mordant (B) Potassium Aluminum sulphate and (C) Copper sulphate



A. **B.** **C.**

Fig. 3 : Shades obtained with turmeric treatment with (A) no mordant (B) Potassium Aluminum sulphate and (C) Copper sulphate

difference between thicknesses of the cell walls. *S. aureus* has a thicker cell wall (Nadtochenko *et al.*, 2005, Mirjalili and Karimi, 2013). They also showed that using mordant had better antibacterial activity. Similar findings were also reported by Mirjalili and Karimi (2013) who found that mordants have shown to have a positive effect on antimicrobial activity of dyed samples.

The treated samples showed excellent colour fastness properties. When the treated samples were preserved upto one year, the samples did not show any colour fading and maintained the original texture. Furthermore, the samples were found to be resistant to common moths and micro-organisms.

Conclusion:

In conclusion mordants have been proved to be useful chemicals in the natural dyeing process. Alum seemed to be the best mordant. The most variation came with the dye sources and various mordants. With each mordant, the sources had a different hue. This study mainly focused on the exploration of dye sources and uses of different mordants to find out different hue. Mordants have shown to have a positive effect on colour fastness of dyed samples. Moreover, wash durability was considerably improved by mordanting. One aim of this paper was to popularize the concept of natural dye and to stimulate discussion and inspire some form of collaboration across the fields of natural dye practice and sources and potential possibilities that the colouring pigments present in natural dyes could provide in terms of health and wellbeing. Certain natural dyes and colorants have been proven to possess medicinal healing qualities, these could be exploited to provide mankind for more than just colour and initiate a return to wearing clothing dyed with natural dyes.

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