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Dyeing of Cotton with Natural Dye Obtained from Flower of *Tecoma stans*

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Abstract:

The synthetic dyes which are of wide commercial importance cause severe atmospheric and environmental pollution. Use of natural dye has increased several folds in the past few years due to ecofriendly approach of the people.The present investigation was carried out for dyeing with natural dye obtained from flowers of *Tecoma stans* belongs to bignoniaceae family, commonly knows as Ginger Thomas. The trumpet-shaped flowers are clustered at the branch tips. The individual flowers are broadly tubular, 2 inches (5 cm) long, and have 5 rounded lobes. The flowers are followed by 8 inch (20 cm) long, narrow, brown seed pods. In the present study, scoured cotton fabric was dyed with chemical and natural mordants . Dyeing was carried out by pre-mordanting, post mordanting and simultaneous mordanting. The dyed samples have shown good washing, light and rubbing fastness properties. The production cost of the *Tecoma stans* flower dye was estimated.

Keywords: Natural dye, *Tecoma stans*, Mordants, Cotton

1.0 Introduction:

In the beginning there were only dyes derived from natural sources like plants, minerals or animals. Natural materials were the only source of dye until 1856, after the accidental synthesis of 'manure' coloured coal tar produced by William Henry Perkin was the starting point of the synthetic dye. The prominence of natural dyes slacked because the synthetic dyes had some advantages over natural dyes like colour fastness, good reproducibility of shades, brilliance of colour and easy to use (Anderson,1971). These synthetic dye stuffs produced hazardous by-products some of which possess carcinogenic intermediates. Nowadays, there is increasing awareness among people towards natural dyes. Natural dyes have better biodegradability and higher compatibility with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable (Onal, 1996; Pruthi et al., 2007; Saba and Dutta; Siva 2007; Adeel et al., 2009). *Tecoma stans* is a Central and South American tree that grows to 25 feet. It has bright yellow flowers and dense, lushly green foliage that is evergreen intropical climates, but deciduous in chiller places. Other names of this tree are Ginger Thomas, Yellow elder, Tronadora trumpetbush, Yellow bells etc. This tree grown throught out Tamilnadu. It is used in traditional medicine for diabetes. *Tecoma stans*, also known as roble amarillo, saíco amarillo, boiscaraîbe, trumpet flower, yellow-elder, and many other common names (Little and Wadsworth 1964), is a medium-sized shrub with many branches and basal stems. The leaves are opposite, pinnately compound with 5 to 13 saw-toothed leaflets. The twigs are green, turning brown, and the older bark is light gray and very furrowed. A profusion of bright yellow flowers has made the species much loved throughout the tropics. *Tecoma stans* is the official flower of the U.S. Virgin Islands. *Tecoma stans* does not tolerate heavy frost. However, it will grow in most well-drained soils, including calcareous fill, infertile sands, acidic Ultisols, and volcanic egolith in areas receiving from 700 to 1800 mm of rainfall.

The species is described as a water spender that is able to convert to a water saver (Tipton 1994). *Tecoma stans* produces flowers that have functional male and female parts. The tubular flowers are fragrant, 4 to 5 cm in length, and pollinated by bees and other insects and hummingbirds. The 10- to 25-cm pods (capsules) develop in about 1 month and liberate large numbers of papery-winged seeds. The species may flower and fruit nearly throughout the year (Little and Wadsworth 1964) in climates without strong seasonal change, or flower heavily in autumn in seasonal climates such as southern Florida. Developing pollen becomes sterile when temperatures rise above 34 °C. This leads to seed failures during summer months in many areas (Kumar and Singh 1988). Natural reproduction may

vary from dense to cattered. In nurseries, *Tecoma stans* is usually propagated from seed, although greenwood cuttings can also be rooted (Baily 1941). A collection of seeds from Puerto Rico averaged 208,000 seeds/kg. Germinating began in 3 days and finished with 97 percent germinated (Francis and Rodríguez 1993). No pregermination treatments are necessary. *Tecoma stans* is planted as an ornamental throughout the topics and subtropics. It is especially prized as a flowering hedge plant. The shrub is planted and managed to enhance the beauty of green belts and natural forests used for recreation. Used in combination with trees, *Tecoma stans* contributes to effective windbreaks and sound breaks. Growing in thick patches that shade out grass, the species has become a serious weed in Brazilian pastures (Kranz and Passini 1997).Browsing cattle and goats in Mexico consume up to 20 percent of the leaves and 100 percent of the available flowers (Susano Hernandez 1981). The foliage in one study in India contained 17 percent crude protein, 6 percent ash, 18 percent fat, 25 percent fiber, and 14 percent total polyphenols (Nag and others 1994). *Tecoma stans* leaves, bark, and roots contain many biologically active chemicals, and extracts from those tissues have been used in traditional folk medicine to treat many diseases and conditions (Liogier 1990). Perhaps the most promising compounds are monoterpine alkaloids, which have been shown to effectively reduce the symptoms of diabetes mellitus in rats, dogs, and mice (Aguilar et al., 1993, Lozoya-Meckes and Mellado-Campos 1985, Perez et al., 1984).

2.0 Materials and Methods

2.1 Materials:

2.1.1 Source:

The flowers of *Tecoma stans* was collected from Abraham Pandithar Nursery Garden, Thanjavur,Tamilnadu, India. The flowers were dried in shadow and then ground into powder using lab model grinding machine.

2.1.2 Substrate:

100% cotton cloth was purchased from Khadi Craft Store, Thanjavur.

2.1.3 Chemical Used:

AR grade metallic salts such as Copper sulphate, Ferrous sulphate, Ferric chloride, and Potassium dichromate were used as chemical mordants. Myrobolon and cow dung were used as natural mordants.

2.2 Methods

2.2.1 Dye Extraction:

Flowers of plant were soaked in distilled water and heated in a beaker kept over a water bath for 2 hours to facilitate quick extraction. Then it was filtered and the filtrate was collected in a separate beaker. The filtrate was concentrated upto high viscous state. This extract is used for dyeing cotton.

Fig1: Flowers of *Tecoma stans*

2.2.2 Scouring of Cotton Cloth:

Scouring of cotton cloth was done by washing it in a solution containing 0.5g/lit sodium carbonate and 2g/lit non-ionic detergent (Tween 80) at 50ºC for 25 mins, keeping the material to liquor ratio at 1:40. The scoured cloth was thoroughly washed with tap water and dried at room temperature. The scoured material was soaked in clean water for 30 min prior dyeing or mordanting.

2.2.3 Dyeing Procedure:

The cotton samples were dyed with dye extract keeping M:L ratio as 1:20. Dyeing was carried out at 80ºC and continued for 1 hour.

2.2.4 Mordanting:

The wetted out cotton samples were entered into dye baths containing required amount of dye extract and water. After 10 minutes, required amount of sodium carbonate and sodium chloride were added. The dyeing was carried out for 1 hour at 60 ºC. The dye samples were dried in air without washing to make them ready for pre, simultaneous and post-

mordanting using different metallic salts and natural mordants.

i) Pre-mordanting:

Scoured cotton samples with or without pre-mordanting were further mordanted prior to dyeing using 1-3% of any one of the chemical mordants, such as Copper sulphate, Ferrous sulphate, Ferric chloride, and Potassium dichromate and natural mordants,such as myrobolon and cow dung , at 60ºC for 30 minutes with material-to-liquor ratio of 1:20. The samples treated with metal salts were dyed with the dye extract (Kumaresan et al.,2011).

ii) Simultaneous-mordanting:

Scoured cotton samples were treated with both dye extract and metal salts simultaneously, using 1-3% of any one of the chemical mordants, such as Copper sulphate, Ferrous sulphate, Ferric chloride, and Potassium dichromate and natural mordants,such as myrobolon and cow dung , at 60ºC for 30 minutes with material-to-liquor ratio of 1:20(Kumaresan et al.,2011).

iii) Post-mordanting:

Scoured cotton samples were dyed with dye extract. The wetted out cotton samples were entered into different dye bath containing required amount of dye extract and water. After 10 minutes required amount of sodium sulphate was added. After 20 minutes required amount of sodium chloride was added. The dyeing was carried out for 1 hour at 50ºC. The dyed samples were taken out. Squeezed and used for treatment with metal salts process without washing. The dyed cotton samples were treated with different metal salts using 1-3% of any one of the chemicals mordants, such as Copper sulphate, Ferrous sulphate, Ferric chloride, and Potassium dichromate and natural mordants, such as myrobolon and cow dung , at 60ºC for 30 minutes with material-to-liquor ratio of 1:20(Kumaresan et al.,2011).

2.2.5 Fastness Tests:

The dyed material was tested for light fastness, wash fastness and rub fastness. The colour fastness is usually rated either by loss of depth of colour in original samples or it expressed by staining scale (Samanta and Agarwal, 2009). Light fastness was analysed by exposing the dyed materials to direct sun light for 24 hours. The wash fastness was carried out by washing the dyed fiber with non-ionic soap (1g/lit). The rub fastness of the dyed fiber was carried out by rubbing the fiber and checking for fading of colour (Adeel et al., 2009; Raja, 2010; Mishra and Patni, 2011).

2.2.6 Fastness Tests:

Cost sheet is a statement, which shows various components of total cost of a product. It classifies and analyses the components of cost of the product. To fix the selling price of a product or service, it is essential to prepare the cost sheet. It helps in fixing selling price of a product or service by providing detailed information of the cost. The costing was done taking into consideration the direct expenses, overheads and administration charges. (Kulkarni et al., 2011).

3.0 Result and Discussion:

Different shades of yellow were obtained from the dye extracted from the flowers of *Tecoma stans*. These different shades are obtained from a single dye, using different mordants like Copper sulphate, Ferrous sulphate, Ferric chloride, Potassium dichromate, myrobolon and cow dung. Mordants play very important colour to the fabric. The different mordants used gave varying shades. Various hues of colour were obtained from pre, simultaneous and post-mordanting, as shown in Fig.2. It was observed that, the dye uptake was found to be good in three methods.

The mordanted cotton cloth was immediately used for dyeing because some mordants are light sensitive. The chromophore of the dye makes it resistant to photochemical attack, but the auxochrome may alter the fastness. Wash fastness of the dye is influenced by the rate of diffusion of the dye and state of the dye inside the fibre (Jothi, 2008). With regards to colour fastness, test samples exhibited excellent fastness to washing (except pre, simultaneous and post-mordanting – Potassium dichromate and cow dung); excellent fastness to rubbing(except pre, simultaneous and post-mordanting – Potassium dichromate and cow dung); and fairly good fastness to light. For washing, rubbing and light fastness the rating are given to 1 to 5. The fastness rating of 5 indicates that the dyed materials are possessing excellent fastness and the rating of 1 indicates that the fastness is very poor (Raja et al., 2012). The production cost was estimated to be Rs.8140 per Kg of *Tecoma stans* flower dye. This included the cost of raw materials and chemicals used, electricity consumption, packing transportation, labor and administration charges.

Cost Sheet fir 1Kg of *Tecoma stans* flower dye

Sl. No.	Particulars	Rupees
1)	**Direct Material**	
	Flower of *Tecoma stans*(30Kg)	2500
	Water(60L)	1500
	Total	4000
2)	**Direct Labor** (Rs.500 for 3 days)	1500
3)	**Direct Expenses**	
	Water bath and heating expenses	1500
	Prime Cost	7000
4)	Add: Overheads	
	Administrative Expenses (Travelling and Stationery)	250
	Packing Material	150
	Total Cost	**7400**
5)	**Profit Margin 10%**	740
	Selling Price	**8140**

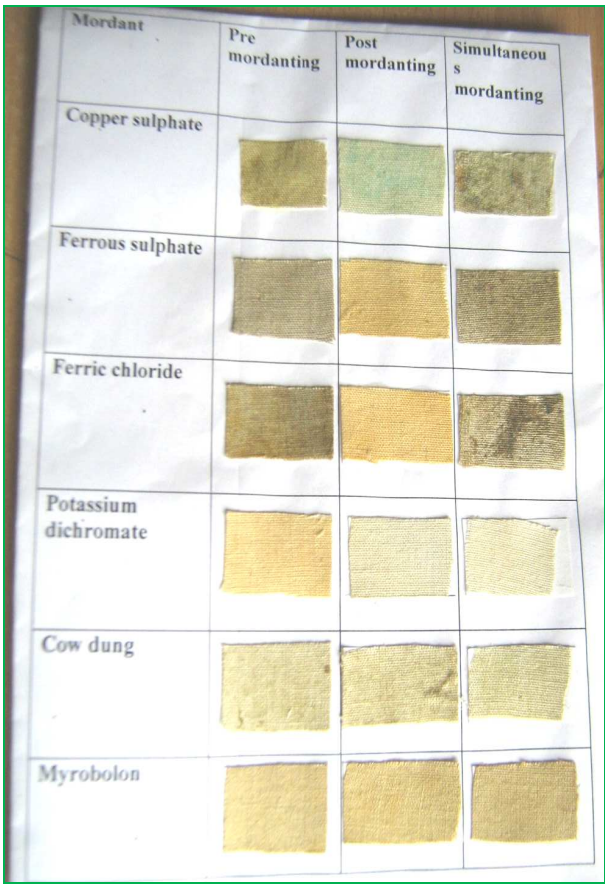

Fig.2: Application of Dye on Cotton Cloth

Table 1: Fastness Properties for Cotton Fabric Dyed with *Tecoma stans*

Mordants	Method of Mordanting	Washing	Rubbing	Light
Copper sulphate	Pre-mordanting	**4**	**4**	**4**
	Post mordanting	**3**	**3**	**3**
	Simultaneous mordanting	**4**	**4**	**4**
Ferrous sulphate	Pre-mordanting	**4**	**4**	**4**
	Post mordanting	**4**	**2**	**4**
	Simultaneous mordanting	**4**	**4**	**4**
Ferric chloride	Pre-mordanting	**4**	**4**	**4**
	Post mordanting	**4**	**2**	**3**
	Simultaneous mordanting	**4**	**4**	**4**
Potassium dichromate	Pre-mordanting	**3**	**4**	**3**
	Post mordanting	**3**	**4**	**3**
	Simultaneous mordanting	**3-2**	**2**	**2**
Cow dung	Pre-mordanting	**3**	**3**	**3**
	Post mordanting	**3**	**3**	**3**
	Simultaneous mordanting	**3**	**2**	**3**
Myrobolon	Pre-mordanting	**3**	**4**	**4**
	Post mordanting	**4**	**4**	**4**
	Simultaneous mordanting	**4**	**4**	**4**

4.0 Conclusion:

The present work shows that, flowers of *Tecoma stans* can be used as a dye for colouring textiles. These are grown throughout world and also easily available. Different shades of colour can be obtained using different chemical and natural mordants. Cotton treatment with metallic salt and natural mordants for pre, post and simultaneous mordanting method are effective in acidic medium.

The dye extract was acidic in nature (pH=3.0). The washing ,rubbing and light fastness of all dyeing with mordants were quite good. The process of extraction of dyeing is environmental friendly and causes minimum environmental pollution. Use of other mordants, combination of mordants may also be considered for improving the fastness of dyed cloth further research will help to explore the important properties of dye extracted from flowers of *Tecoma stans*. The detail studies for natural dyes have established that in most cases their properties are comparable to those of synthetic dyes. Therefore, if natural dyes have to be commercialized they need to confirm to the same stringent standard of performance that are applied to synthetic dyes.

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