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# Evaluation of Colour Fastness Properties of Natural Dyes on Mulberry Silk

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**ABSTRACT: The colour fastness properties of mulberry silk yarn dyed with natural dyes extracted from root, rhizome, bark, flowers, seeds, fruits, of beet root, *Beta vulgaris*; turmeric, *Curcuma longa;* arjun tree, *Terminalia arjuna;* gulmohar, *Delonix regia;* annatto, *Bixa orellana;* mulberry, *Morus indica* respectively, and fungi *Penicillium purpurogenum* have been studied. Hot water extraction method was used to extract the dyes from the plant parts. Silk bleaching was done by oxidation process. Investigations were carried out at the Department of Sericulture, TNAU, Coimbatore. Natural dye has good scope in the commercial dyeing of mulberry silk in the garments industry. The dyed silk samples have shown good colour fastness properties in washing, perspiration (acid, alkali), light and rubbing (dry and wet). The dyed silk samples were evaluated for their colour fastness to washing, rubbing, light and perspiration at Arthanari Loom Centre (Textile) Pvt. Ltd., Salem using the methods prescribed by the International Organization for Standards (ISO).**

**Keywords:** Natural dyeing of silk-plants and microbe- staining and colour fastness.

## INTRODUCTION

The use of natural dyes for textile dyeing purposes decreased to a large extent after the discovery of synthetic dyes in 1856. As a result, with a distinct lowering in synthetic dye stuff costs, the natural dyes were virtually unused at the beginning of twentieth century. Presently, there is an excessive use of synthetic dyes, estimated at around 10,000,000 tons per annum, the production and application of which release vast amount of waste and unfixed colourants causing serious health hazards and disturbing the eco-balance of nature (Goodarzian, 2010). But natural dyes have better biodegradability and generally have higher compatibility with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable (Kulkarni *et al.,* 2011). The increasing awareness of health and pollution hazards of chemical dyestuffs has led to a resurgence of interest in natural and mineral colours (Gupta *et al.,* 2013). Natural dyes are mostly used for dyeing of the textiles from natural fibers to enhance their eco-friendly characteristics. Apart from indigo, other natural dyes are usually not used for printing directly. Natural dye covers all the dyes derived from the natural sources like plants, animal and minerals (Jordeva *et al.,* 2020)

## MATERIALS AND METHODS

**Extraction of natural dyes from plants.** Freshly collected plant parts *viz.,* root, rhizome, bark, flowers, seeds and fruits were washed thoroughly with running tap water and shade dried at room temperature for 2 h. In the case of turmeric, the dried rhizome was ground into fine powder. Hot water extraction method was used to extract dyes naturally for which the powdered samples were soaked in distilled water and heated in a beaker kept over a water bath for 1 h at 70° C to facilitate quick extraction. The extracts were filtered using double layered muslin cloth. It was again filtered using a Whatman No.1 filter paper to remove vegetative debris and the filtrate was collected in a separate beaker and stored at 4° C in refrigerator (Pubalina *et al.,* 2018).

**Extraction of natural dyes from microbe.** *P. purpurogenum* fungal culture was grown on Potato Dextrose Agar (PDA) medium. Sterile media were poured into sterile petri dishes and after solidification of media, 0.6 cm diameter mycelia disc of the fungi were placed into it. Then the plates were incubated for five days at room temperature (28 ± 2°C). The plates were examined by visual observation for growth and pigmentation on agar media.

The pure culture of fungi was cultivated in 3 litres of optimized broth (per litre of deionized water) and pH 5.6 in Haffins flask. 12 mm diameter of corkborer was used to inoculate mycelia disk from PDA culture of *P. purpurogenum* which were grown at 27° C in the dark as stationary cultures for 4-6 weeks in the flask (Nagia and EL-Mohamedy, 2007). After an incubation period of six weeks, the mycelium was harvested, and the supernatant was filtered in a sterilized muslin cloth.

The optimized medium for pigment production in fermentors was sterilized at 121° C, 15 lbs pressure for 1 h. After sterilization, the fermentor temperature was brought down to 40° C with zero atmospheric pressure and the medium in the fermentor was collected directly from the fermenter outlet to the 2/3rd volume of 25 litre capacity Poly Propylene (PP) cans plugged with sterilized cotton. To this sterilized medium, mycelia mat of selected fungal pigment producer were inoculated separately. Fermentation period was for seven days at room temperature. At the end of incubation, the respective pigment was collected by separating the mycelia from the fermented broth. Then the collected pigments were filtered through muslin cloth in sterilized containers.

**Dyeing of silk.** Pre-treatment methods such as degumming and bleaching were done to the silk fabric to remove impurities. Bleaching was done by oxidation using an oxidizing bleaching agent. Silk weighing 50 g was soaked in a solution of detergent (25 g/l) for 30 min, removed and rinsed twice with distilled water at room temperature. The fabrics were then placed in the bleaching solution (7 g washing soda + 3 g detergent) and heated to a temperature of 60° C for 90 min. During this process, the fabrics were agitated by stirring continuously. They were removed from bleaching bath and washed with distilled water, rinsed repeatedly and shade dried (Jordeva *et al.,* 2020).

In this method, the bleached silk samples were treated with different dyes.

The wetted-out silk samples were directly dipped into different dye baths containing dye extracts (25%) and the dyeing was carried out for half an hour at 60°-70° C. The dyed samples were placed in the dye solution at room temperature for 5 hrs. After that, the dyed samples were taken out, squeezed and washed with industrial soap by using cold water repeatedly and dried in air.

**Evaluation of colour fastness**

| Properties | Test Method |
|---|---|
| Washing | ISO-105-E01 |
| Light | IS 2454 |
| Rubbing | ISO-105 -X12 |
| Perspiration | ISO-105-E04 |

## RESULTS AND DISCUSSION

The colour fastness results for the staining on multifibres in *T. arjuna* showed slight changes (grade 4) to water and perspiration fastness. This was followed by *B. orellana* and *C. longa* which showed noticeable change to slight change (grade 3-4 and 4) by water and perspiration fastness. *P. purpurogenum* recorded noticeable changes to slight change (grade 3-4) by water and alkaline perspiration; noticeable change to acidic perspiration. *M. indica* and *D. regia* showed noticeable change to slight change (grade 3 and 3-4) to water fastness; noticeable change to perspiration and washing at 40° C. *B. vulgaris* recorded noticeable change (grade 3) to water, considerable to noticeable change to perspiration (Table 1).

**Table 1: Scores of staining on multifiber by different natural dyes.**

| Fastness properties | Silk dyed in 5 h soakingperiod | | | | | | |
|---|---|---|---|---|---|---|---|
| | ***B. vulgaris*** | ***C. longa*** | ***T. arjuna*** | ***D. regia*** | ***B. orellana*** | ***M. indica*** | ***P. Purpurogenum*** |
| **Water fastness** | | | | | | | |
| Acetate | 3 | 4 | 4 | 3 | 4 | 3-4 | 3 |
| Cotton | 3 | 3-4 | 4 | 3-4 | 3-4 | 3 | 3 |
| Nylon | 3 | 4 | 4 | 3-4 | 3-4 | 3-4 | 3-4 |
| Polyster | 3-4 | 4 | 4 | 3 | 4 | 3-4 | 3 |
| Acrylic | 3 | 4 | 4 | 3 | 4 | 3-4 | 3-4 |
| Wool | 3 | 3-4 | 4 | 3-4 | 3-4 | 3 | 3-4 |
| **Alkaline perspiration** | | | | | | | |
| Acetate | 3 | 4 | 4 | 3 | 4 | 3 | 3-4 |
| Cotton | 2-3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |
| Nylon | 3 | 4 | 4 | 3-4 | 4 | 3 | 3-4 |
| Polyster | 3 | 3-4 | 4 | 3 | 4 | 3-4 | 3 |
| Acrylic | 3 | 3-4 | 4 | 3 | 4 | 3 | 3-4 |
| Wool | 2-3 | 3-4 | 4 | 3 | 3-4 | 3 | 3-4 |
| **Acidic perspiration** | | | | | | | |
| Acetate | 3 | 3-4 | 4 | 3 | 4 | 3 | 3 |
| Cotton | 2-3 | 4 | 4 | 3-4 | 4 | 3 | 3 |
| Nylon | 2-3 | 3-4 | 4 | 3 | 4 | 3 | 3 |
| Polyster | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |
| Acrylic | 2-3 | 4 | 4 | 3 | 4 | 3 | 3 |
| Wool | 2-3 | 3-4 | 4 | 3-4 | 3-4 | 3 | 3 |
| **Washing at 40° C** | | | | | | | |
| Acetate | 3 | 4 | 4 | 3 | 4 | 3-4 | 3-4 |
| Cotton | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |
| Nylon | 2-3 | 4 | 4 | 3 | 4 | 3 | 3-4 |
| Polyster | 3 | 4 | 4 | 3 | 4 | 3 | 3-4 |
| Acrylic | 3 | 3-4 | 4 | 4 | 3-4 | 3 | 3-4 |
| Wool | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |

**Scores for staining**: 1-Much change, 2-Considerable change, 3-Noticeable change, 4-Slight change and 5-Negligible change

The fastness ratings of silk dyed with natural dyes are presented in Table 2. Colour change gradings of *T. arjuna* recorded good to excellent (grade 4-5) fastness to wash; good fastness (grade 4) to perspiration and rubbing; moderate to fairly good fastness to (grade 3-4) light. This was followed by *B. orellana* and *C. longa* which showed fair to good (grade 3-4) fastness to wash, perspiration and rubbing (grade 3-4) and moderate fastness to light (grade 3). *D. regia* and *M. indica* showed fair to good (grade 3-4) fastness to water; fair (grade 3) fastness to perspiration and rubbing and poor to moderate (grade 2-3) fastness to light. *P. purpurogenum* showed fair to good (grade 3-4) fastness to water and alkaline perspiration; fair (grade 3) fastness to acidic perspiration and rubbing and poor to moderate (grade 2-3) fastness to light. *B. vulgaris* showed fair (grade 3) fastness to water, alkaline perspiration and dry rubbing, and poor to fair (grade 2-3) fastness to wet rubbing and very poor to poor (grade 1-2) fastness to light.

**— Scores for water/ Alkaline perspiration/ Acidic perspiration/ Washing at 40° C/ Dry rubbing/ Wet rubbing fastness test**: 5-Excellent; 4-Good; 3- Fair; 2-Poor; 1-Very poor.

**— Score for light fastness test**: 1- very poor; 2- poor; 3- moderate; 4- fairly good; 5- good; 6- very good; 7- excellent; 8- outstanding From the results, it was observed that among the seven natural dyes, 25 per cent concentration of *T. arjuna* at 5 h soaking period showed better fastness properties compared to other dye extracts used. This may be attributed to the fact that terminalia barks are rich in tannin (Pandey and Kori, 2009). Tannins and flavonoids are considered to be very useful substances during the dyeing process because of their ability to fix dyes within fabrics (Mongkholrattanasit and Punrattanasin, 2012). Tannins are commonly used in the dyeing industry as effective mordants, because of their rich binding properties. *T. arjuna* contains high amount of tannin, flavanoides and other phenolic compounds (Mandal *et al.,* 2013). Soaking of dyes on silk also

might improves the colour fastness properties. Five hour soaking is enough because, more soaking time might reduce the strength of silk.

**Table 2: Fastness properties of silk dyed with natural dyes.**

| Fastness properties | Silks dyed in 5 h soaking period | | | | | | |
|---|---|---|---|---|---|---|---|
| | ***B. vulgaris*** | ***C. Longa*** | ***T.arjuna*** | ***D.regia*** | ***B.orellana*** | ***M. indica*** | ***P. purpurogenum*** |
| Water fastness | 3 | 3-4 | 4-5 | 3-4 | 3-4 | 3-4 | 3-4 |
| Alkaline perspiration | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3-4 |
| Acidic perspiration | 2-3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |
| Washing at 40° C | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3-4 |
| Rubbing –Dry | 3 | 3-4 | 4 | 3 | 3-4 | 3 | 3 |
| Rubbing –wet | 2-3 | 3-4 | 4 | 3 | 3-4 | 2-3 | 3 |
| Light | 1-2 | 3 | 3-4 | 2-3 | 3 | 2-3 | 2-3 |

The flavonoid, quercetin present in the extracts of *C. longa,* is the colouring compound (Mongkholrattanasit and Punrattanasin, 2012). Curcumin is a main colouring substance in *C. longa*. So, might be because of those compounds are the reason for producing colours on silk without the use of any mordants.

Janani and Winifred (2013) explained about the dyes from the leaves of coffee and mulberry plants produced colours on cotton fabrics without the application of any mordant in the dyeing process. Coffee and mulberry leaves gave yellow green and buff brown colours respectively. Coffee and mulberry leaves gave fair (grade 3) and good to excellent (grade 4/5) fastness for wash, good (grade 4) fastness to heat and good (grade 5) fastness for light. Tannin-based dyes are used for textile dyeing for their good substantivity towards them because of more numbers of auxochromic groups in coloring components (Shabbir *et al.,* 2017).

According to Hanumantha *et al.,* 2020, *T. arjuna* bark on cotton showed good washing (grade 4) and excellent light fastness (grade 5) without the use of any mordants.

## CONCLUSION

Some of the natural dyes could produce better colours on fabrics and can give excellent colour fastness properties without the use of any chemical mordants, this may be due to the presence of an appropriate natural mordants (binder for fabrics) in the selected natural dyes. In the present work 25 % concentration of *T. arjuna* at 5 h soaking period showed better colour fastness properties on silk compared to other dye extracts used. This may be due to the presence of high amount of tannin, flavanoides and other phenolic compounds. More scientific studies are needed on dyeing of silk with natural mordant dyes to improve the fastness properties and to overcome the limitation of natural dyes.

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## REFERENCES

Ghosh, S. K., Das, A.B., and Bhattacharyya, R. (2014). Improvement of Quality of a Modern Commercial Silk Mill through effective Process and Machine Control Parameters. *American Journal of Engineering Research (AJER), 3 (5):*73-79.

Goodarzian, H. and Ekrami. E. (2010). Extraction of dye from madder plant (*Rubbia Tinctorium* L) and dyeing of wool. *World Applied Sciences Journal*, *9*(4): 434-436.

Gupta, C., Sharma, D., Aggarwal S., and Nagpal, N. (2013). Pigment production from *Trichoderma spp*. for dyeing of silk and wool. *I.J.S.N.*,4(2): 351-355.

Hanumantha, M., Mahalakshmi, M., Sannapapamma, K.J., Sakeena Naikwadi and Roopa, S Patil. (2020). Effect of mordanting methods on colour strength and colour fastness properties of organic cotton dyed with *T. arjuna* bark. *Journal of Pharmacognosy and Phytochemistry, 9* (1): 650-654.

Janani, L. and Winifred, D. (2013). Suitability of dyes from mulberry and coffee leaves on silk fabrics using eco-friendly mordants. *International Journal of Scientific and Research Publications, 3* (11): 2250-3153.

Jordeva, S., Marija K., Silvana, Z., Sashka, G. L., Kiro, M. (2 0 2 0 . Dyeing of textiles with natural dyes. *Tekstilna Industrija, 68* (4): 12-21.

Kulkarni, S.S., Gokhale, A.V., Bodake, U.M., and Pathade, G.R. (2011). Cotton dyeing with natural dye extracted from pomegranate peel, *Universal Journal of Environmental Research and Technology, 1 (2):* 135-139.

Mandal, S., Patra, A., Samanta, S., Roy, A., Mandal, T.D., Mahapatra, S., Pradhan, K. D and Nandi, D. K. (2013). Analysis of phytochemical profile of *T. arjuna* bark extract with antioxidative and antimicrobial properties. *Asian Pac. J. Trop Biomed*., *3* (12): 960-966.

Mongkholrattanasit, R. and Punrattanasin, N. (2012). Properties of silk fabric dyed with eucalyptus, quercetin, rutin and tannin using padding techniques. *RMUTP International Conference: Textiles and Fashion.* Bangkok Thailand.

Nagia, F.A. and EL-Mohamedy, R.S.R. (2007). Dyeing of wool with natural anthraquinone dyes from *Fusariumoxysporum, Dyes Pigm*., *75 (2):* 550-555.

Pandey, A. K., Kori, D.C. (2009). Variations in Tannin and Oxalic acid Content in *T. arjuna* (Arjuna) Bark. *Phcog Mag., 5* (18):159-64.

Pubalina, S., Singhee, D., Samanta, A. K. (2018). Fundamentals of natural dyeing of textiles: Pros and Cons. *Current Trends in Fashion Technology &Textile Engineering*, *2*(4) ID.555593.

Shabbir, M., Islam, S.U., and Bukhari, M.N. (2017). Application of Terminalia chebula natural dye on wool fiber-evaluation of color and fastness properties. Text Cloth Sustain 2, 1.