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Optimization of Extraction and Dyeing Conditions of Natural Dye from *Butea monosperma* (Lam.) Kuntze Flowers and Development of Various Shades

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Abstract

In recent years a growing interest in the revival of natural dyes has been manifested. This interest is a result of worldwide movement to protect the environment for discriminate exploration and pollution by industries. As natural dyes are compatible with nature due to their non-hazardous properties and produce colors that are gentle, soft and subtle, they are recovering their lost importance. Extraction & dyeing conditions of natural dyes from flowers of *Butea monosperma* have been optimized in neutral medium *i.e.* water and various beautiful shades developed on cotton fabrics using different chemical mordants are being described in this article. Also, described the phytochemical screening of extracted dyes.

Key words: *Butea monosperma*, natural dyes, extraction, cotton fabric, mordants, phytochemical screening

Introduction

Colors in the day to day life of man are very prominent and unavoidable. It is associated in the form of colored dress materials, hair, furnishings, upholstery etc. Dyes are mainly of two types: natural and synthetic. As far as natural colours and dyes are concerned, India has a very rich tradition of using natural dyes and also virtual monopoly in their production and applications. Dyeing & printing was a craft up to the middle of nineteenth century. There are many references in the literature and calico printing is an example. References are also available for silk dyeing with natural colors in China before 2600 BC (Siva, 2007). Caves of Ajanta & Bagh (6^{th} century AD) are undoubted proof of the natural colors. Numerous specimens of dyeing and printing of ancient period are still available in the museums. All this happened due to the excessive use of synthetic dyes which is esteemed around 1 million tons per annum of which more than 50% were azo dyes (Stolz, 2001). After the advent of synthetic dyes in the middle of 19^{th} century, natural dyes were abandoned as a part of history due to neglect for about 150 years. It is only during the last two decades, when concern for environment as well as carcinogenicity in synthetic dyes created an interest in biodegradable, eco-friendly, non-toxic and aesthetically appealing natural dyes, its production and R & D (Sewekow, 1988, Eom *et al*., 2001, Padhy and Rathi, 1990, Garg *et al*., 1991).

Butea monosperma (Lam.) Kuntze (Family: Fabaceae), is commonly known as 'flame of forest' or 'Tessu or Palash' and various other names in different parts of India and abundantly found in the forests of central India. The plant is well known for its natural dye. Tiwari and Vankar (2001) extracted dyes from tessu flowers by soaking in alkaline medium at 9-10 pH for 2 hours. Optimization of extraction conditions is a must to minimize the investment cost and to avoid discrepancy in the dyed shade quality. Therefore, a need to explore the eco-friendly method of extraction of dye is felt. The objectives of our study were to i) optimize the extraction conditions of natural dye from *Butea monosperma* flowers in neutral medium, ii) optimize dyeing conditions for cotton fabric and iii) evaluate the extracted dye for its phytochemicals.

Materials and Methods

The flowers of *Butea monosperma* were collected from campus of Tropical Forest Research Institute, Jabalpur (Figure 1 and 2). The mordants *viz.*, Potassium aluminium sulphate, copper sulphate, ferrous sulphate, potassium dichromate, tannic acid and stannous chloride used in this study were of LR grade. Pure handloom khadi cotton was used in dyeing experiments. The optical density was measured by UV-Visible spectrophotometer. Distilled water was used in extraction and for preparation of all chemical solutions and for dyeing fabrics.

Figure 1 Flowers on the branch of *Butea monosperma* tree

Preparation of samples for extraction of dye: The flowers were collected and dried in shade. The shade and air-dried flowers were powdered in a grinder and stored in plastic bags at room temperature (Bhuyan and Saikia, 2005).

Figure 2 Flowers of *Butea monosperma* spreading on the ground

Process optimization for extraction & isolation of dye: Different amounts (2–12 gm) of powdered flowers of *Butea monosperma* were placed in beakers containing 100 ml of distilled water and each was extracted for one hour over a gentle flame maintaining a temperature of 95 – 97^{o}C, filtered and made to 100 ml. 1ml of this liquor was diluted to 100 ml again and the optimum amount of powdered flowers to water ratio for the extraction of dye was determined by measuring the optical density as shown in Table 1. Similarly, the time for dye extraction from flowers was also optimized as given in Table 2.

Table 1 Optimization of flowers powder concentration and water ratio

S. No.	Weight of flower (g)/ 100 ml of water	Extraction time (minutes)	Wave length (nm)	Optical density
1.	2	60	271	0.7308
2.	4	60	271	0.9309
3.	6	60	271	1.3661
4.	8	60	271	1.2252
5.	10	60	271	0.7723
6.	12	60	271	0.9529

Table 2 Optimization of time for the flowers dye extraction

S. No.	Weight of flower (g)/ 100 ml of water	Extraction time (minutes)	Wave length (nm)	Optical density
1.	6	30	271	1.0582
2.	6	45	271	1.2809
3.	6	60	271	1.3249
4.	6	75	271	1.1780
5.	6	90	271	1.1135

Extraction & Isolation of dye from flowers: Based on above experiments, the dye from the flowers of *Butea monosperma* was extracted by heating the powdered flowers with water (1:17) at 95 - 97°C for 1 hrs. The dye solution was filtered and evaporated to dryness to obtain the solid mass (35%).

Determination of optimum dye concentration: Dye solutions of different concentrations (0.2 to 1.4%) were prepared and the optical density of each solution was measured after diluting 1ml of solution to 100 ml with distilled water. Thereafter 7 cotton samples of 0.8 gm each were dyed in each of the respective dye solutions for 30 minutes at 90-95^{o}C. The optical density of each residual dye solution was also measured after dyeing the fabric. The absorbance percentages were calculated and reproduced in Table 3. It was also experimented that a maximum of 0.8 gm of cotton fabric can be dyed in 0.4% of dye solution. The criteria for evaluation were the depth of the colour, evenness of dye and brightness of shade.

Table 3 Percentage of absorption in different dye concentrations by cotton fabric

S. No.	Wavelength (nm)	Time (min)	Dye solution (%)	Wt of cotton (gm)	OD before dyeing	OD after dyeing	Percentage of absorption %
1.	415	60	0.2	0.8	0.058	0.034	35.84
2.	415	60	0.4	0.8	0.090	0.057	36.66
3.	415	60	0.6	0.8	0.122	0.091	25.40
4.	415	60	0.8	0.8	0.159	0.118	25.78
5.	415	60	1.0	0.8	0.205	0.162	20.97
6.	415	60	1.2	0.8	0.238	0.188	21.00
7.	415	60	1.4	0.8	0.259	0.209	19.30

Determination of optimum time for dyeing: Six number of solutions each having dye concentration of 0.4% were prepared and the optical density of each solution was measured after diluting 1ml of solution to 100 ml with water. Thereafter 6 cotton samples of 0.8 gm each were dyed in prepared dye solutions for 15, 30, 45, 60, 75 and 90 minutes respectively at 90-95^{o}C. The optical density of each residual dye solution was also measured after dyeing the fabric. The absorbance percentages were calculated and reproduced in Table 4.

Table 4 Percentage of absorption for same dye concentration at different time by cotton

S. No.	Wavelength (nm)	Time (min)	Dye solution (%)	Wt. of cotton (gm)	OD before dyeing	OD after dyeing	Percentage of absorption %
1.	415	15	0.4	0.8	0.09	0.088	02.22
2.	415	30	0.4	0.8	0.09	0.071	21.11
3.	415	45	0.4	0.8	0.09	0.063	30.00
4.	415	60	0.4	0.8	0.09	0.570	36.66
5.	415	75	0.4	0.8	0.09	0.580	35.55
6.	415	90	0.4	0.8	0.09	0.570	36.66

Dyeing method: Dyeing on cotton was carried out by post mordanting method which produced improved shades in terms of hue and darkness. The dye bath was set 4 gm per liter of the dye by keeping the material to liquor ratio of 1:100. The dye bath was set and a temperature of 90 - 95°C was maintained by heating the solution for 60 minutes for dyeing the 0.8 gm cotton piece. The dye bath was cooled to room temperature and the dyed fabrics were directly transferred to mordant bath for mordanting (Dayal *et al*., 2006).

Determination of optimum concentration of mordant: The mordant solution of 0.1% to 1.0% was prepared in distilled water and was used for mordanting to standardize the optimum concentration of mordant. The dyed samples were directly immersed in the mordant baths having different concentrations by keeping the material to liquor ratio of 1:100. The bath was heated to a temperature of 90 - 95°C for 60 minutes for fixing the dye on cotton. The bath was allowed to cool and samples were taken out from cooled bath, washed with water and dried in shade. The developed color was visually examined on cotton cloth.

Determination of optimum time for mordanting of cotton samples and development of different colour shades: The solutions of different mordants (0.5% concentration) were prepared in distilled water and were used for mordanting. The dyed fabric samples were directly immersed in the mordant bath. The bath was heated to a temperature of 90-95°C for 15, 30, 45, 60, 75 and 90 minutes respectively for fixing the dye on cotton. The bath was allowed to cool and samples were taken out from cooled bath, washed with water and dried in shade. The developed color was visually examined on cotton cloth.

Phytochemical screening of dye: The preliminary phytochemical screening of solid dye was carried out which has shown the presence of phenols, flavonoids, terpenoids and carbohydrates in the solid dye as given in Table 5.

Table 5 Qualitative analysis of solid dye for phytochemicals

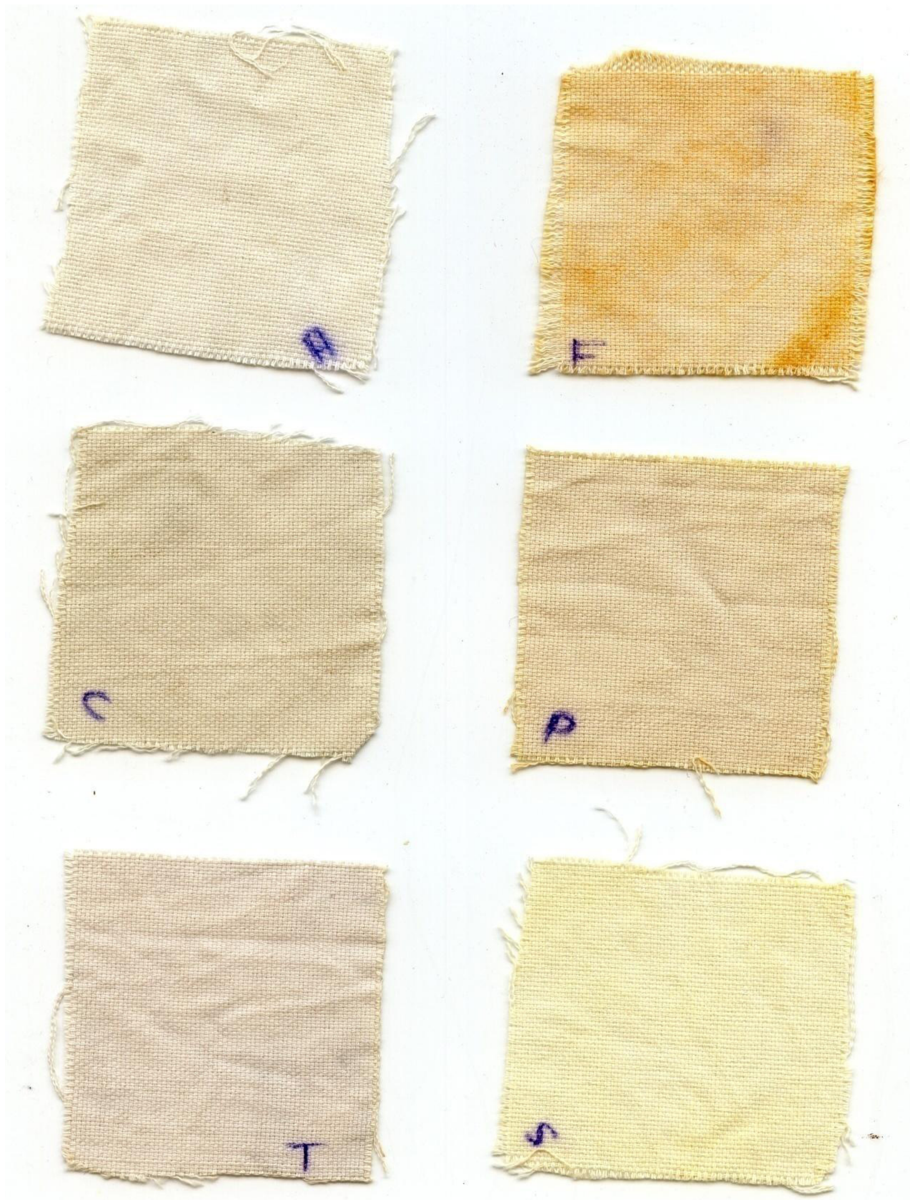
S. No.	Phytochemicals	Qualitative test
1.	Tannins	Absent
2.	Alkaloids	Absent
3.	Flavonoids	Present
4.	Terpenoids	Present
5.	Steroids	Absent
6.	Cardiac glycosides	Absent
7.	Carbohydrates	Present
8.	Phenols	Present
9.	Saponins	Absent

Result and Discussion

It is clear from the Table 1 and 2 that 6 gms of dried flower powder of *Butea monosperma*, should be heated in 100 ml of water (material liquor ratio 1:17) at 95 - 97°C for 60 minutes for maximum dye extraction. The yield of dye is 35%. The data in Table 3 and 4 showed that 0.8 gm of cotton fabric can be dyed in 0.4% dye solution for optimum colour. The criteria for evaluation were the depth of the colour, evenness of dye and brightness of shade. The visual observations indicated that 0.5% solution of each mordant with material to liquor ratio of 1:100 heated up to a temperature of 90 – 95^{o}C for 60 minutes for cotton fabric was found to be optimum. The post mordanting method gave the best colour with all the mordants. The different colours have been obtained using various mordants because of formation of complexes between the polyphenols and organic compounds in the dye with metal ion of mordant, which absorbs in different regions of visible spectrum leading to different colours. The results in Table 5 showed the presence of phenols, flavonoids, terpenoids and carbohydrates in the solid dye.

Some of the shades developed on cotton fabrics using different mordants are given in annexure 1.

Annexure 1



A = Potassium aluminum sulphate
F = Ferrous sulphate
C = Cupric sulphate
P = Potassium dichromate
T = Tannic acid
S = Stannous chloride

Conclusion

Butea monosperma is very common in the forests of central as well as other parts of India. Since, the commercialization of natural dyes heavily depends on systematic & scientific approach, low investment cost and efficient, eco-friendly, energy saving unconventional dyeing techniques, the optimum conditions standardized may be utilized for extraction of dye in neutral medium in an eco-friendly manner as well as dyeing cotton fabrics to get improved shades.

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References

Bhuyan, R., Saikia, C.N., 2005. Isolation of colour components from native dye-bearing plants in Northeastern India. *Bioresource Technology* 96, 363-372.

Dayal, R., Dobhal, P.C., Kumar, R., Onial, P., Rawat, R.D., 2006. Natural dyes from *Lantana camara* leaves. *Colourage* 53-56.

Eom, S., Shin, D., Yoon, K., 2001. Improving the dyeability of natural colourants on cotton by cationization. *Indian Journal of Fibre & Textile Research* 26 (4), 425–431.

Garg, A., Shenda, S., Gupta, K.C., 1991. Effect of mordants on colour of natural dye extracted from tesu flowers (*Butea monosperma*). *Colourage* 38 (2), 50–53.

Mahanta, D., Tiwari, S.C., 2005. Natural dye-yielding plants and indigenous knowledge on dye preparation in Arunachal Pradesh, Northeast India. *Current Science* 88, 1474 – 1480.

Moses, J.J., 2006. Natural Dyes: Scope and Challenges, chap. 16, pp 161 – 173. Scientific Publisher, Jodhpur, India.

Padhy, R.N., Rathi, D., 1990. Effect of mordants on dyeing of cotton with vegetable dyes. *Textile Dyer & Printer* 23 (25), 27–28.

Sewekow, U., 1988. Natural dyes - an alternative to synthetic dyes. *Melliand Textilber* 69 (4), 145–148.

Singh, R.V., 2001. Colouring plants – An innovative media to spread the message of conservation. *Down to Earth* 20, 25–27.

Singh, V., Singh, R.V., 2002. Healthy hues. *Down to Earth*, 11, 25–31.

Siva, R., 2007. Status of natural dyes and dye-yielding plants in India. *Current Science* 92 (7), 916 – 925.

Stolz, A., 2001. Basic and applied aspects in the microbial degradation of azo dyes. *Applied Microbiology and Biotechnology* 56, 69 - 80.

Tiwari, V., Vankar, P.S., 2001. Unconventional natural dyeing using microwave and sonicator with alkanet root bark. *Asian Textile Journal* 10(5), 54-57.