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Home Science

EXTRACTION OF NATURAL DYES FROM FUNGUS – AN ALTERNATE FORTEXTILE DYEING

Ms. Tehmina Pathan — Temp. Teaching Assistant, Textile and Apparel Design, Institute of Fashion Technology, The Maharaja Sayajirao University of Baroda, Vadodara.

Dr. Falguni Patel* — Assistant Prof., Department of Clothing and Textiles, The Maharaja Sayajirao University of Baroda, Vadodara. *Corresponding Author

ABSTRACT There is a growing interest in the revival of natural dyes in textile coloration. The prominence of natural dyes slacked down because synthetic dyes had some advantages over natural dyes like colour fastness, good reproduction of shades, brilliance of colours and easy to use and also for ready availability of pure synthetic dyes of different types/ classes and its cost advantages, most of textile dyers/ manufacturers shifted toward use of synthetic colourant. Apart from being used in textile industry, natural dyes are now days used in cosmetics, leather, food and pharmaceutical industry. Microbial dyes have some advantages over plant and animal based dyes as microbes are fast growing and have the potential of being standardized commercially. Microbial dyestuffs produce rare colour ideas and are automatically harmonizing. Unlike, non-renewable basic raw materials for synthetic dyes, these natural dyes are usually renewable and biodegradable and generally have a higher compatibility with the environment than synthetic dye therefore, no disposal problem of this natural waste.Theproduction and evaluation of microbial pigments as textile colorants is currently being investigatedby the BritishTextile Technology Group (BTTG).Present study has been made to explore the microbial world as potential textile dyes. The different type of growth media those are used in microbiology. Inoculate different pigment giving microbes and extract dye for dyeing textile. After dyeing spectrophotometer evaluation of the samples was done and wash fastness analysis was undertaken.The main objectives of study was to explore the microbial world as potential source of natural dyes.To assess the isolated strains for chromophoric microbes for their suitability as a textile dye.To study the fastness properties of the dyed textile material against various agencies of wear. To fulfil these objectives the study was designed in two phases i.e. Phase 1, and Phase 2, where the Phase 1 was dealing in exploration for microbes isolates showing chromo genesis. Phase 2 was optimization of the dyeing parameter and assessment of the final dyed samples. The experimental research design was conducted for flow of work.In the study total 63 NA and PDA plates were exposed to soil, air, food for obtaining unknown pigment producing microbes. Four known culture also used.22 microbes strains were found to produce pigment on NA and PDA plates.The extracted pigment from the screened 5 microbes strains was checked for its dyeability by dyeing with mordanted and unmordanted multi-fibre fabric.The 5 species were screened from soil, MTCC and food.The dye extracted could colour only wool, silk and acrylic in all cases. Cotton samples did not dye even with the use of mordants.Optimization of dyeing variables in order to time, temperature, M:L ratio, method of dyeing.It was found that *Fusarium solani* gave best results on mordanted wool and silk. The percentage exhaustion of wool is more than silk sample. The percentage exhaustion of *Fusarium solani* is 36% for wool and -79% for silk respectively. Samples were also visually examined and found to have darker shade on wool than silk.From colour values of final dyed samples, it was concluded that wool has higher K/S and lower L* value than silk, hence wool has higher colour depth than silk.

KEYWORDS : Chromosomal abnormality, Bad obstetric history, genetic counseling.

INTRODUCTION

Humankinds' interest in colour; has resulted in the alchemy of exploring nature to utilize the colour offered in various ways; be it adorning the body with colour of the mud or colouring the textile that man wears. Thus, the art of dyeing has a long past and use of natural dye stuff for dyeing are as old as textile themselves. Synthetic as well as natural colours are integral part of our everyday life. Before the invention of synthetic dyes, natural colours were used for all applications. However in modern days mostly synthetic colours are widely used as they are relatively cheap and easily available. The continuous use of large quantities of synthetic dyes used for various applications is of great environmental concern because of pollution caused due to synthetic dye industry. Many artificial synthetic colours which have been widely used in foodstuff, dyestuff, cosmetic and pharmaceutical manufacturing processes, are reported to cause allergic reactions and other health hazards such as cancer.

Scientists conclude that microorganisms originated an estimated 4 billion years ago from complex organic materials in ocean water, or possibly in vast cloud banks surrounding our primitive earth. As the first life on the earth, microorganisms are thought to be the ancestors of all other life forms. Natural dyes and pigments are emerged as an important alternative to potentially used synthetic dyes in textile industry as few synthetic dyes really causes pollution and are allergic to skin. To defeat this constrain, it is suggested to exploit the potentiality of other biological sources such as fungi, bacteria, and cell cultures, since appropriate selection, mutation or genetic engineering techniques are likely to improve significantly the pigment production yields with respect to wild organisms. Natural pigments exhibit better biodegradability and higher compatibility with the environment than do synthetic dyes.

2. MATERIALS AND METHODS

2.1 Materials: Dyeing was done on silk and wool fabrics. A mulberry silk of thread count 89 ×114 and twill woven woollen fabric of thread count 50 × 27 were used. Mordants like Harda and Alum were used for pre-mordanting at 10% and 15% on the owf respectively.

2.2 Fungal Isolates

For microbial fermentation various fungi were isolated from food and soil. For isolation fungi, PDA (Potato dextrose agar) plates were prepared. PDA is solid medium containing Potatoes infusion from 200 gms/ litre, Dextrose 20 gms/ litre, Agar 15 gms/ litre in distilled water to grow fungi. Pure fungi were inoculated on potato dextrose broth for pigment production. The *Fusarium solani* fungi finally selected for the study. *Fusarium solani* sourced from Department of Microbiology and Biotechnology Centre, The Maharaja Sayajirao university of Baroda, Vadodara.

2.3 METHODS

2.3.1 Fungal isolates

Total 63 NA plates were prepared to obtain microorganisms. 1 gm of Soil samples were dissolved in 5 ml of distilled water in a test tube. Then soil solution was spread onto the NA plates with the help of sterile spreader.

a) Soil 55 sample (48 soil samples collect from dye manufacture industry + 7 garden soil)
b) Air (1 sample)
c) MTCC (3 bacterial culture and 1 fungi)
d) Food (3 fungi)

All NA plates were then kept in incubator at 37°C for 24 hours. Different bacterial colonies appeared on NA plates from which pure cultures of the microbes were obtained by transferring them onto NA/PDA plates and then kept again in an incubator at 37°C for 24 hours. *Aspergillus niger* and *Fusarium solani* were used for further study.

2.3.2 Fungal Cultures for Pigment Production

Cultures of *Fusarium solani* and *Aspergillus niger* were grown on potato dextrose broth. All the flasks were inoculated at room temperature. Fungal cultures broths showing colour were filtered with Whatman no.1 filter paper after 3 weeks and 4 weeks for *Fusarium solani* and *Aspergillus niger* respectively.

2.3.3 Dyeing

The coloured filtrates from all the broths were then used for dyeing multi-fibre fabric. The samples were unmordanted and pre-mordanted with 15% harda and 10% alum on the weight of fabric. After pilot study finally pre-mordanted wool and silk, each weighing 1gm, were dyed in 30 ml of coloured filtrate using MLR: 1:30, dyeing 45 minutes, and temp 80°C. After dyeing washing of samples carried out by cold water.

2.3.4 Fabric Properties

Percentage Absorption: Percentage Absorption of the dyed fabric was also calculate on spectrophotometer using the following equation:

$$\% \text{ absorption} = \frac{\text{O.D. before dyeing} - \text{O.D. after dyeing} \times 100}{\text{O.D. before dyeing}}$$

Colour Measurement and fastness: Colour values, such as K/S, L*, a*,b*, were calculated on computer colour matching system. Dyed samples were tested for wash fastness according to ISO standards.

3 RESULTS AND DISCUSSION

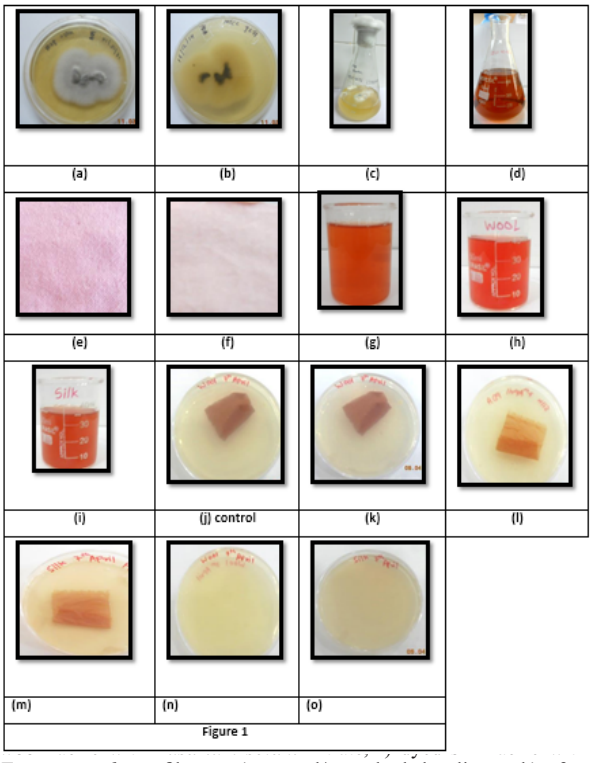
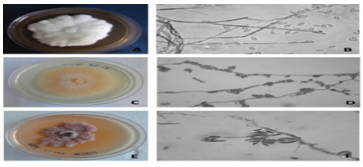


Figure 1

Fusarium solani filtrate, g) control/ standard dye liquor, h) after dyeing wool fabric liquor, i) after exhaustion liquor of silk, j) control wool fabric for checking microbial re-growth, k) microbial re-growth in the dyed wool sample after 48 hours,l) control silk fabric for checking microbial re-growth, m) microbial re-growth in dyed silk sample after 48 hours, n) exhausted dye liquor after dyeing wool for checking microbial re-growth, o) exhausted dye liquor after dyeing silk for checking microbial re-growth.]

3.1 Screened Fusarium solani (MTCC 9671) and filtrate

The pure culture of *Fusarium solani* was isolated from chilli fruit sample using Potato Dextrose Agar plates. *Fusarium solani* was isolated and purified at Department of Microbiology and Biotechnology Centre.



{**(A)** *Fusarium solani* (Cc50) with cottony white growth. **(B)** *Fusarium solani* (Cc50), many conidiophores arising from long, branched hyphae.**(C)** *Fusarium delphinoids* (Cc52); flat,cottony and yellow colony. **(D)** *F. delphinoids*,conidiophores arising laterally from hyphae later more or less loosely branched.**(E)** *Fusarium solani* (Cc149) with curved margin, white colony releasing pink pigmentas. **(F)** *F. solani* (Cc149), Conidiophores arising from septate hyphae.}

3.3 Assessment of final dyed samples

After optimization of dyeing parameters for *Fusarium solani* pigment, the final dyed wool and silk fabric were assessed in terms of their colour fastness properties, k/s value and % exhaustion.

a) Percentage exhaustion

The exhaustion (dye uptake) of *Fusarium solani* from its aqueous solution to wool and silk fibres during application was

TABLE1: Percentage exhaustion of wool and silk dyed with Fusarium solani

Sr.no.	Textile	*Fusarium solani* PDB Medium (80°C)			
		O.D before dyeing	O.D after dyeing	WL(nm)	Percentage exhaustion
1	Wool	2.790	1.790	360	36%
2	Silk	2.790	5.000	510	-79%

Where O.D = Optical density of the dye liquor, W.L. = Wavelength

From **table 1,** It is observed that the percentage exhaustion of *Fusarium Solani* is 36% for wool and -79% for silk respectively. Hence the percentage exhaustion of wool is good compared to the silk sample for *Fusarium solani.* The amorphous regions of fibre determine the penetration of dye molecule into the fibre. More affinity of the above dye for the wool than that for silk is the consequence of presence of more number of amino groups in wool fibre than that in silk and more amorphous region in the morphological structure of wool fibre than that in the silk fibre, which makes the positive site of the substrate more available and accessible for the negatively charged dye **(Graph 1 and 2**). Although the table also indicates that the exhaustion is negative in case of silk which could be attributed to the fact that surplus mordant from the silk leached to give turbidity to the dye liquor but the K/S value of silk indicates comparable results to wool. Samples were also visually examined and found to have darker shade on wool than silk.

a) Colour value

Colour values like K/S, L*,a*,and b* readings were calculated on computer matching system of Premier colour scan SS 5100 A, dual beam spectrophotometer.

Results are as followed:

Wool and silk samples were compared through computer colour matching system and arrived at K/S, L*, a* and b* readings.

CIE L*a*b* (CIELAB) is the most complete colour space specified by the International Commission on Illumination (Commission International d'Eclairage, hence its CIE initialise). The three coordinates of CIELAB represent the lightness of the colour (L*= higher value indicates lighter shades and lower value indicates deeper shades), its position between red and green (a*=nagetive values indicate green while positive values indicate red) and its position between yellow and blue (b*=negative values indicate blue and positive values indicate yellow).

TABLE 2: Colour value of dyed fabric

	K/S	L*	a*	b*
Wool	**1.801**	**58.755**	**12.830**	**6.058**
Silk	**1.185**	**71.450**	**8.854**	**12.711**

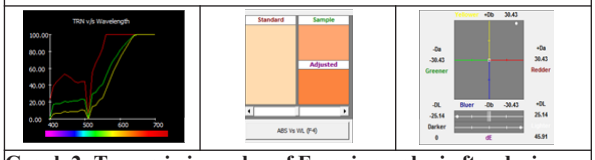
From colour values obtained as shown in table 2 It was found that wool has higher K/S and lower L* values than silk, hence wool has higher colour depth than silk. The a* value of *Fusarium Solani* dyed wool and silk samples is positive thus indicating red component. The b* value of all the dyed samples is in positive thus indicating yellow component.

Relative colour strength (K/S value) is determined using Kubelka – Munk equation:

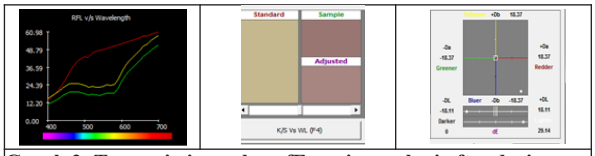
$$K/S = \frac{(1-R)^2}{2R} --- \frac{(1-R)^2}{2R}$$

Where, R is the chemical fraction of the reflectance of dyed fabric, R_o is the decimal fraction of the reflectance of undyed fabric, K is the absorption coefficient and S is the scattering coefficient.

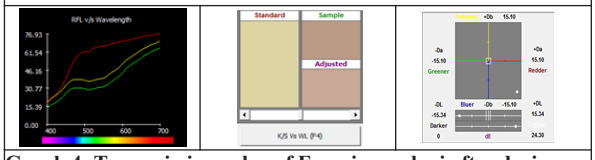
Graph 1: Transmission value ofFusarium solani after dyeing wool fabric



Graph 2: Transmission value of Fusarium solani after dyeing silk fabric



Graph 3: Transmission value ofFusarium solani after dyeing wool fabric



Graph 4: Transmission value of Fusarium solani after dyeing silk fabric

c) Assessment of fastness properties- Colour fastness to washing

Colour fastness to washing was conducted on final dyed sample of wool and silk. Assessment of fastness involves visual determination of either change in shade or staining of an adjacent material. The results are tabulated as follows in table 3.

TABLE 3: Colour fastness test of final dyed samples of wool and silk dyed with *Fusarium solani (MTCC 9671).*

Colour fastness to washing	Wool	Silk
Staining on white	4	3
Change in colour	3	2

Are as per standard geometric grey scale by ICI (As specified by the Society of Dyers and Colourists) was used for visual assessment to evaluate the rate of staining and colour change of the dyed samples. The rating given above in table 3 Are as per standard geometric scale. After analysing the table it was found that fastness to wash of wool sample was good with rating scale of 4. There was staining on white at rating of 4 and change in colour is rating 3. In silk sample poor wash fastness observed as compare to wool sample. Using of different mordants and mordanting technique it can be improved.

3.4 Assessment of microbial re-growth in the dyed sample

The dyed wool and silk fabric was tested for any active *Fusarium Solani* spore present in the dyed fabric. Also the dye liquor left after dyeing was tested for any active *Fusarium Solani* pore present in the exhausted dye before it was discarded by using spread plate method. The plate was visually checked for any *Fusarium Solani* fungal growth present around and under the dye sample placed on the PDA plate. The result depicted in figure Indicates that there was no fungal growth present in the plates even after an incubation period of 48 hours. No fungal growth was observed in dyed samples and exhausted dye liquor thus confirming that the dyed fabric and exhausted dye liquor was free of fungal spores and are invulnerable.

CONCLUSION

Hence, it can be concluded from the present study that fungi Fusarium solani can be a potential source for obtaining dye which can be readily produced in laboratory independent from variables like season. This dye can be applied on silk and wool. The fungi does not regrow on the dyed fabric as well as the exhausted dye liquor, which establishes the fact that the fungi is rendered completely sterile during dyeing.

Therefore, fungi can be a potential source of cultivating dyes which can be adequately applied on textile. Sources of these dyes producers are readily available and found abundantly in soil, air and other habitats.

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