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Research Article

Use of Peanut Skin for the Dyeing of Cotton Fabric

Mona Verma*, Saroj S. J. Singh and Neelam M. Rose

Department of Textile and Apparel Designing, I. C. College of Home Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar

Abstract

Ancient art of dyeing of textiles substrate with natural dyes withstood the destructive effect of time but a swift decline in natural dyeing continued due to the ample availability of synthetic dyes at an economical price. However, even after a century, the uses of natural dyes never eroded completely and are still being used. Natural dyes are obtained from plants renewable parts and wastes, shellfish, insects and minerals. India is still a major producer of most natural dyed textiles and the researches have been carried out to preserve the tradition of natural dyes. Natural dyes can exhibit biodegradability, medicinal properties such as antibacterial property, antioxidant, ultraviolet protection property and generally have a higher compatibility with the environment. In the present study the peanut skin was taken as a natural dye for the colouration of cotton textile. To make the process of dyeing more eco-friendly, there is need to select the natural mordant. Hence, the biopolymers (chitosan, sericin) were tried and their effectiveness was assessed in terms of colour strength and wash fastness basis. It was found that the chitosan showed the highest percent dye absorption (64.06), colour strength (14.14) and very good (4/5) wash fastness.

Keywords: Cotton. Biopolymer, Peanut Skin, Natural Dye, Chitosan

***Correspondence**

Author:Mona Verma

Email:mona.verma35057@gmail.Com

Introduction

The textile dyeing industry growth is accelerating rapidly to fulfill the consumer's demands and colouration technology has dominated this industry. Colour of textile material play an important role in marketability of fabrics due to its psychological effect and catches the attention of the consumers. But the colouring of textiles material is intricate and specialized science in which colour is imparted by using the dyes and pigments through process of dyeing and printing.The global consumption of textiles is estimated to grow at the rate of 3 percent per annum. The colouration of this huge quantity of textiles needabout 7,00,000 tonnes of dyes and such a huge amount of required textiles substrate cannot be dyed and printed with natural dyes only. Therefore, the utilization of environmental friendly synthetic dyes is the need of an hour. But a certain portion of coloured textiles can always be supplemented and managed by eco-safe natural dyes [1].Natural dyes, when used by themselves have many limitations of fastness and brilliancy of shade. However, when used along with metallic mordants they develop bright and fast colours. Therefore, instead of using unsustainable technology for producing colours one can use mild chemistry to achieve almost similar results. The rich biodiversity of our country has provided us plenty of raw materials, yet sustainable linkage must be developed between cultivation, collection and their use. Natural dyes can produce special aesthetic qualities, which, combined with the ethical significance of a product that is environmentally friendly, gives added value to textile production [2].

Cationic modification agentsconsist of two functional characteristics such as multiple functional groups that could react with cotton under alkaline conditions and cationic amino groups that could reduce the negatively charged barrier between fiber and dye. Modification is possible with the help of biopolymers, an environmentally benign route. It is well-known that biopolymers are capable of forming ionic interactions with cotton cellulose by rendering positive charge and provide other functional properties to fibre. Bioploymerscan replace the salts such as alum, ferrous sulphate, sodium sulphate, sodium carbonate and sodium chloride which have been widely used for dyeing of cotton with natural and synthetic dyes to improve the fastness properties and absorption of dye. Biopolymers offer the complete elimination of electrolytes (salts) with low volume of water duringwash off process and provides maximum dye absorption and colour strength which significantly contribute in saving of process cost.

Chitosan is a versatile polycationic biopolymer derived from alkaline deacetylation of chitin. Chitosan exhibits several valuable inherent properties such as antibacterial, antifungal, antiviral,non-toxic, biodegradability which will contribute to minimize the pollution load on environment and to explore promising approach to provide multi-functionality to the cotton fabric.Hence the present study was undertaken to utilize salt free dyeing on cotton using

natural dyeafter biopolymer treatments and the comparison was made among biopolymer treated dye fabric with conventional treated (alum treated) dyed fabric to study the effectiveness of different methods.The Table1&2 depicts the peanut skin which was taken as natural dye for the dyeing of cotton fabric. Natural phenolic compounds can be extracted from peanut skins as these are discarded as a low economic value by-product of the peanut industry; however, they contain high levels of bioactive compounds including catechins and procyanidins, which are known for their health-promoting properties. The three classes of phenolics were found in peanut skins**(***Arachishypogeae)*, including phenolic acids, flavonoids and stilbene. Due to their low cost, peanut skins have great potential to serve as an economical source of natural antioxidants and natural dye.

Table 1 Natural Dye (Peanut Skin)

S. No.	Plants Name	Parts Used	Peanut	Dye materials (Peanut Skin)
1.	Peanut	Skin		

Methods

Assortment of natural dye material

The peanut skin (reddish in colour) were collected and dried. After being completely dried, the material was crushed into small pieces, pulverized into coarse powder and stored in a air tight containers free from environmental climatic changes, till usage.

Table 2 Plants material used for dyeing of cotton fabric for selection of dye

S. No.	Local name of the plant	Botanical name of plant	Family	Part used as dye
1.	Peanut	Arachishypogeae	Fabaceae	Skin

Preparation of Cotton Fabric

Desizing and scouring treatments were given to the woven cotton fabric to remove starch, waxy material and vegetative impurities before imparting finish. *Enzymatic desizing:*The cotton fabric was given desizing treatment using 2ml/l Americos Amylase 543 at 60^0C temperature for 60 minutes with 1:20 material to liquor ratio by maintaining 7 pH. The treatment liquor was drained out and given one hot rinsed and cold wash and dried [3].*Enzymatic scouring:*Desized cotton fabric was scoured in a bath containing 1.5 % (owf) Palkoscour APCL enzyme, at 60 ^{0}C for 60 minutes at material to liquor ratio 1:15 maintained at 7.0 pH. The fabric was rinsed in hot and cold water and dried [4].

Treatment with Biopolymers

Three biopolymers i.e. beta- cyclodextrins chitosan and sericin were taken and applied on cotton fabric separately and dyed with peanut skin dye. Comparison was made among the three biopolymer on the basis of colour strength (k/s) value and wash fastness in terms of colour change (CC) of dyes.

Selection of extraction method for natural dye

Three different mediums of extraction were used and one medium of extraction was chosen on the basis of presence of phytochemicals in dye extract, simplicity of process and cost. Aqueous extraction method was selected. *Aqueous extraction:* Aqueous extract was prepared by soaking 10 g of dye powder in 100 ml distilled water, in a stainless steel vessel overnight to loosen the cell structure. The mixture was boiled at 80-85°C for 1 hour to get the dye solution, allowed to stand till it reached to room temperature and filtered to remove non dye plant remnants**.**

Application of biopolymer

Beta-cyclodextrin: The surface modification of cotton fabric was carried out with beta cyclodextrin (0.75 g/l) and cross-linking agent (citric acid 0.25 g/l) at 80^0C for 60 minutes using 1:30 M:L Ratio. The treated samples were washed and dried. *Chitosan application*: Scoured cotton fabric was soaked in 1 % chitosan solution (dissolved in 1%

acetic acid (v/v) containing 6% citric acid and 6% sodium hypophosphite and squeezed in padding mangle for uniform fixing and dried at 80^{0}C for 10 minutes followed by fixing at 100^{0}C for 5 minutes [5].*Sericin application:* Cotton sample was dipped in 0.50 percent sericin solution (owf) with 4% concentration of citric acid and 1% sodium hypophosphite using 1:30 material to liquor ratio at pH 8.0. The fabric was treated for 45 minute at 50^{0}C temperature. The fabric was passed between padding rollers, dried at 70^{0}C for 4 minutes and cured at 150^{0}C for 2 minutes [6].

Dyeing method

Dyeing of mordanted cotton samples was done with 5% dye owf using 1:30 M:L Ratio at 70 ^{0}C for one hour. The samples were washed with hot water followed by cold water and dried in shade [7]and [8].

Percent dye absorption

Percent dye absorption was calculatedusing the following formula

$$\text{Percent dye absorption} = \frac{\text{OD before dyeing} - \text{OD after dyeing}}{\text{OD before dyeing}} \text{ X } 100$$

OD= Optical Density

Colour measurement

The colours of dyed samples were measured numerically through computerized colour matching machine. The reference spectra of dyed samples were observed by using spectrophotometer SS5100A, K/S value and CIE LAB co-ordinates L*, a* and b* were noted down directly from the computer screen. This spectrophotometer uses CIE LAB (1976) colour space, D65 illuminate matching and appraisal and 420 nm wavelength to measure the actual colour and change in colour. The kubelkamunk theory was used to predict the colour value.

$$K/S = (1-R)^2 /2R$$

Assessment of Fastness to washingof dyed fabrics

Wash fastness test was carried out as per recommendation of IS:3361-1979 method (BIS, 1979). The nine- step scale consisting of half fastness rating was used. A piece of original dyed sample and the test specimen was placed side by side in the same plane. The light was incident upon the surfaces at approximate angle of 45^0 and the direction of viewing approximately perpendicular to the plane of surface. The visual differences were compared between the original and tested material with the difference represented by the Grey Scale.

Results

Effect of enzymatic desizing and scouring on the whiteness and brightness index:

The effect of enzymatic desizing and scouring treatment on the whiteness and brightness index of cotton fabric is presented through **Figure 1**. It was observed that after enzymatic desizing of cotton fabric, whiteness index increased from 81.27 to 83.19, brightness index from 70.11 to 70.80 whereas yellowness index decreased from -10.87 to -12.03. It was also noticed from the figure that after enzymatic scouring, the whiteness index increased from 81.27 to 85.40, brightness index from 70.11 to 72.63 and yellowness index decreased from -10.87 to -12.31.

It is clear from the **Table 3**the chitosan treated samples had the highest percent dye absorption (64.06), colour strength (14.14) and very good (4/5) wash fastness rating followed by alum treated dyed sample (60.93 %, 13.99k/s value and 4), beta cyclodextrin dyed sample (60.93 %, 13.25 k/s value and 4)sericin treated dyed sample (59.37 %, 12.80 k/s value and 4).Thus it can be concluded from the Table 3and **Figure 4** that the percent dye absorption and colour strength values of chitosan pretreated dyed sample with peanut skin dye was found higher as compared to alum, sericin, beta-cyclodextrin treated dyed samples. Findings of the study are supported by the [9] that the chitosan treated cotton fabric showed more functional groups (amino and methyl groups) than the untreated cotton fabric. This phenomenon depicted that chitosan provided more sites to attach dye and form functional hydrogen bonds to improve dyeing properties. [10]also found that increased concentration of chitosan provided higher depth of shade. The enhancement of dye absorption occurred due to the formation of additional hydroxyl groups. It was found by [11]and [12]that by increasing in chitosan concentration, there was a significant improvement in color strength (k/s) of cotton

fabric pre-treated with chitosan and enhanced the possibility of dyeing cotton with reactive dyes without addition of salt.

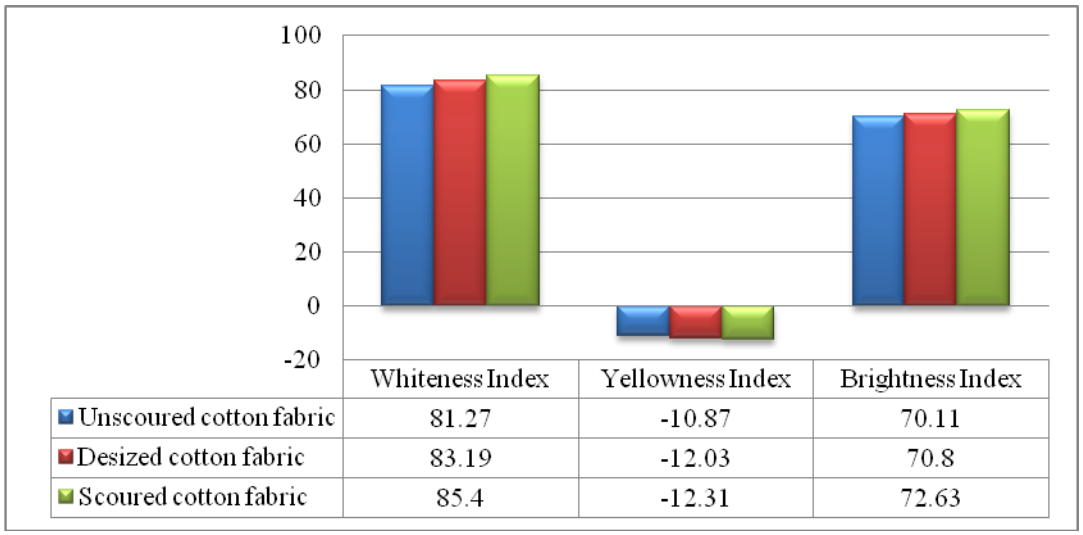

Figure 1 Effect of enzymatic preparatory processes on the whiteness and brightness of cotton fabric

Table 3 Selection of biopolymer and natural dye on the basis of colour properties

S. No.	Natural dyes	Alum treated fabric (control)			Biopolymers treatedfabrics								
					Beta cyclodextrin			Chitosan			Sericin		
		% Dye absorption	Colour strength (k/s)	Wash fastness grades	% Dye absorption	Colour strength (k/s)	Wash fastness grades	% Dye absorption	Colour strength (k/s)	Wash fastness grades	% Dye absorption	Colour strength (k/s)	Wash fastness grades
1.	Peanut skin	60.93	13.99	4	60.93	13.25	4	64.06	14.14	4/5	59.37	12.80	4

Figure 4 Shades Obtained with Natural Dye (peanut skin) on Alum and Biopolymers Treated Fabrics

S. No.	Plants Name	Treated fabrics Alum	Beta-cyclodextrin	Chitosan	Sericin
1.	Peanut Botanical Name:*Arachishypogeae* Family: Fabaceae				

Conclusion

There is a need to look towards the nature which has tremendous resources to be utilized for various purposes. There is abundance of natural material which is discarded as a waste such as chitin which is waste of sea food industry and can be utilized in the form of chitosan (biopolymer) as a finishing agent in textile industry and peanut skin which is also discarded from processing industry can be utilized as dye material. In the present study it was found that the chitosan as a mordant enhanced the dyeability of cotton fabric with natural dye (peanut skin) without using any metallic salt. Thus it was concluded that the chitosan can be utilized as mordant in the dyeing of cotton fabric with natural dye. It is environment benign route because chitosan is safe, non-toxic and biodegradable in nature and have great future in textile industry.The application of eco-friendly natural dyes on textiles has become essential because of the increased environmental awareness and concern to avoid the use of carcinogenic and hazardous synthetic dyes.

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