ECO-FRIENDLY POLYESTER DYEING WITH CROTON OBLONGIFOLIUS

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ABSTRACT

The natural plant source Croton Oblongifolius is mainly used by pharmacologist for its medicinal properties like allergic dermatitis, decoction, to relieve abdominal pains, anti-diarrheal, blood tonic etc. The present research work deals with the extract of the stem bark of this plant having particularly reddish-brown color used to dye hydrophobic polyester, which is difficult to dye using natural dyes. Optimization of dyeing parameters viz., pH conditions, dye concentration, dyeing time and dyeing temperature was been studied. The dyed polyester fabric showed satisfactory results including excellent sublimation fastness. This dyed Polyester with some natural fibers used in medical textile. Findings show that the natural dye extracted from stem bark of croton oblongofolius has good potential in the polyester dyeing and can be exploit further.

KEYWORDS: Croton Oblongifolius, Polyester Dyeing, Fastness Properties.

With growing awareness on environmental-related issues, most of the industries prefer natural dyes over synthetic dyes for textile dyeing. In comparison between natural dyes and synthetic dyes, synthesis of synthetic dyes produces undesirable, hazardous and toxic chemicals where as natural dyes are obtained from renewable sources, biodegradable and less toxic. Demands of polyester fibre in the various industries are due to its durability and strength. They also resist to wrinkles, shrinking, abrasion and mildew. Synthetic fibres suffer from disadvantages such as reduced wearing comfort, build-up of electrostatic charge, the tendency to pill, difficulties in finishing. These disadvantages are largely associated with their hydrophobic nature [Gashti et. al., 2011]. Also polyester can only be dyed with disperse dyes which limits the variations of dyes for polyester dyeing. Dyeing of textiles with natural dyes has long been studied, especially for natural fibers like cotton and silk but rarely with polyester fibers. Majority of the natural dyes are well soluble in water, so they can readily be applied on hydrophilic textile fibers. Thus there is less possibility to produce the natural-dyed synthetic textiles to fulfill a demand on a more eco-friendly textile products [Sriumaoum et. al., 2012]. There are very few natural sources available which can be used as dye for polyester fibre. In this research work, polyester dyeing is done with plant source: Croton oblongifolius (Euphorbiaceae). As there is very little scientific information present on application of it for dyeing, an attempt has been made consciously to use it in colouration of synthetic fibres which can be used in medical textile as dye is from medicinal plant [Mandal and Bose, 2011]. C.Oblongofolis is a weed available all over in the agricultural fields of India. Pharmaceutical approach with this plant is widespread due to its medical properties. Traditionally this plant is also used as wound healing drug.

EXPERIMENTAL

Material

Polyester (100%) was procured from local manufacturer from Mumbai, India. Chemical used for extraction and dyeing i.e. ethanol was purchased from SDF Mumbai, India.

Methods

Extraction of dye from C.Oblongofolis-

The stem bark sample was collected from college campus which was then washed thoroughly with water to remove impurities. It was then dried at 40^0 C in an oven for 24 hrs. The sample was ground into powder with the help of grinder. The process of extraction of dye was carried out in Soxhlet apparatus with ethanol for 3-4 hrs at 78^0C. The mixture was evaporated to dryness in a rotary evaporator flask and final powder product was kept in desiccator.

Optimization of Dyeing conditions-

Dyeing was carried out using conventional polyester and disperse dyeing method. Optimization of concentration of dye (1% to 17 %), temperature (100^0C to 130^0C) and time (30 min to 60 min) was done using material to liquor ratio 1:50. Finally the fabric samples were washed with cold water, hot water, squeezed and dried.

Determination of colour strength value of dyed fabric-

The dyed samples were evaluated for the depth of color by reflectance method using 10degree observer.

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Rayscan Spectrascan 5100+ equipped was used to measure the absorbance of the dyed sample in terms of CIELAB colour space (L*, a* and b*). The K/S values were determined as follows;

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

Where, R is the reflectance at complete opacity; K is the Absorption coefficient & S is the Scattering coefficient.

In general, the higher the K/S value, the higher the depth of the colour on the fabric. L* corresponding to the brightness (100- white, 0- black), a* to the red–green coordinate (+ve- red, -ve -green) and b* to the yellow–blue coordinate (+ve -yellow, -ve -blue) [4], [Tayade and Adivarekar, 2013]. The reproducibility of the results was also checked and was found to be satisfactory in all the cases, showing a standard deviation of the order of ± 0.02.

Fastness Testing

Colourfastness to washing was assessed as per ISO 105-CO2: 1989, Colourfastness to Light on Q-Sun's Xenon Arc Light Fastness Tester as per AATCC 117 – 2004, Colour fastness to Heat: ISO105–P01:1993 [Gies et. al., 2000].

Evaluation of UV Protection factor

UPF (Ultraviolet Protection Factor) of the standard polyester fabric and C.Oblongofolis dyed polyester fabric were measured using AS/NZ 4399:1996 method by SHIMADZU UV-2600 instrument [IS 975-1988].

RESULTS AND DISCUSSION

Optimization of Dyeing Parameters

Effect of dye concentration-

The effect of dye concentration on the fabric was studied, as seen from the fig.1, dye concentration increases from 1% to 17 %, K/S value also increases. From the below graph 15% dye concentration was taken as optimal dye concentration for polyester dyeing. With increase in concentration of dye in the dyebath solubility increases until certain concentration and then decreases. Adsorption of the dyestuff on fibre surface depends on the solubility of the dye in the dye bath and that in the fibre [8].

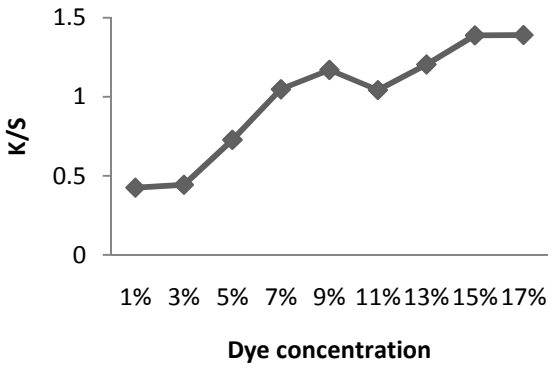

Figure 1: K/S values of the fabric dyed with different concentration of dye

Effect of pH

The extracted dye was acidic in nature and polyester dyeing requires acidic pH (between 4.5-5.5) so no additional chemicals are required for maintaining pH. At this pH dye, exhaustion is satisfactory [8].

Effect of Temperature

The dyeing was conducted at different temperatures i.e. at 100°C, 110°C and 130°C. As shown in Fig.3, it is clear that the K/S value increases with the increase in dyeing temperature and reaches a maximum value at 130°C. Heating is applied to increases the energy of dye molecules in the dye liquor and accelerates the dyeing of textile fibres. At 130°C temperature the molecular chains of the polyester vibrates vigorously and polyester goes from plastic to rubbery stage making it accessible for dye and allows the dye to penetrate into it thus the dye molecule occupy its place in the amorphous regions of the fibre. The dye molecules are held by hydrogen bonds and Van Der Waals'force in its place [8].

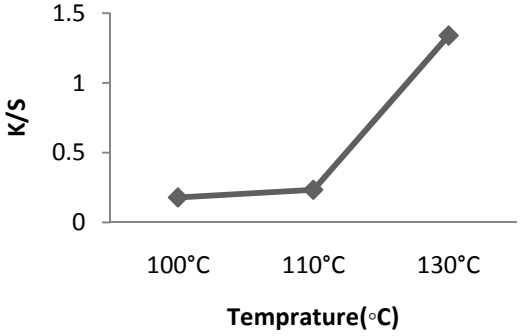

Figure 3: K/S values of the fabric dyed at different temperature

Effect of Dyeing Time

As shown in Fig.4, the colour strength obtained increases as the time increases from 30 mins to 60 mins. Time is the main factor in textile dyeing so from the below graph it is clear that 45 min is optimum time for polyester dyeing as on that treatment of dyeing colour strength is highest and remains constant further.

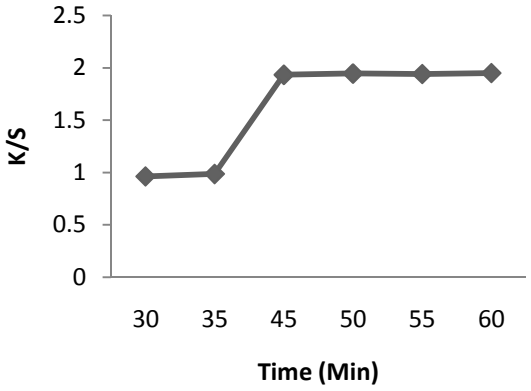

Figure 4: K/S values of the fabric dyed at different time

Fastness Properties

The colourfastness values of the fabrics dyed with C. Oblongofolis dye is given in Table I, II, and III. Sublimation and washing fastness results were assess with respect to grey scale and results for light fastness were assess with respect to blue wool scale.

Results of Sublimation fastness are excellent at 120°C, 180°C and 210°C temperature. Similarly wash fastness and light fastness of dyed polyester fabrics are giving acceptable results.

Table I: Sublimation fastness properties of dyed fabric

Sample		Sublimation		
		120˚C	**180**˚C	**210**˚C
At Acidic pH		5	5	5
Temperature (˚C)	100˚C	4	4	4
	110˚C	4	3	4
	130˚C	5	5	5
Time (Minutes)	30 mins	4	4	4
	45 mins	5	5	5
	60 mins	5	5	5
Dye Concentration (%)	15%	5	5	5
	17%	5	5	5

Table II: Light fastness properties of dyed fabric

Sample		Light Fastness
At Acidic pH		**6**
Temperature (˚C)	100˚C	5
	110˚C	6
	130˚C	**6**
Time (Minutes)	30 mins	5
	45 mins	**6**
	60 mins	**6**
Dye Concentration (%)	**15%**	**6**
	17%	**6**

UPF (Ultraviolet Protection Factor) testing

As shown in table IV, it is clear that in comparison with control polyester sample the dyed polyester fabric gives very good UPF rating. There are various parameters which affect the UV protection factor e.g. nature of fibre, Dyeing, finishing, Moisture etc. The polyester fabric is thin and transparent so the UVR (Ultraviolet radiation) can be easily transmitted into skin. The dyed polyester shows high UPF than undyed polyester fabric due to presence of natural colour pigment. As the time, concentration and Temperature goes on increasing of polyester dyeing the UPF of that dyed fabric also increases due to higher amount of dye in the fibre [Saravanan, 2007].

Table III: Washing fastness properties of dyed fabric

Sample		Washing Fastness						
		Colour Change	Colour Staining					
			AC	C	N	P	A	W
At Acidic pH		**5**	**4**	**4**	**4**	**4**	**4**	**4**
Temperature (˚C)	100˚C	4	3-4	3-4	3-4	3-4	3-4	3-4
	110˚C	4-5	3-4	4	3-4	3-4	4	3-4
	130˚C	**4-5**	**4**	**4-5**	**4**	**4-5**	**4-5**	**4-5**
Time (Minutes)	30 mins	4	3-4	4	3-4	3-4	3-4	3-4
	45 mins	**4-5**	**4-5**	**4-5**	**4-5**	**4-5**	**4-5**	**4-5**
	60 mins	4	4-5	4	4-5	4-5	4-5	4
Dye Concentration (%)	**15%**	**5**	**4-5**	**4-5**	**4-5**	**4-5**	**4-5**	**4-5**
	17%	4-5	4-5	4-5	4-5	4-5	4-5	4-5

*AC-acetate,C-cotton,N-nylon,P-polyester,A-acrylic,W-wool,Temp-temprature

Table IV: UV Protection Factor testing of dyed fabric

Sample		UPF	
		Undyed Fabric	**Dyed Fabric**
At Acidic pH		12.65	33.59
Temperature (˚C)	100˚C		12.71
	110˚C		19.59
	130˚C		33.92
Time (Minutes)	30 mins		21.91
	45 mins		33.90
	60 mins		32.23
Dye Concentration (%)	15%		33.86
	17%		32.78

CONCLUSION

The main focus of the study is extraction of the dye and dyeing of polyester. Natural dyeing of polyester fabric is rare but C.Oblongofolius showed good dyeability to polyester. Dyeing can be carried out at acidic pH and without mordant thus no additional chemicals were required. Dyed fabric gave better sublimation fastness. This natural dye seems to have great potential for the dyeing of polyester being environment friendly with medicinal properties.

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