ORIGINAL ARTICLE Open Access

ISSN 2278-1404

International Journal of Fundamental & Applied Sciences

Eco-friendly colouring of fabric using prickly pear (Opuntia catcus) plant

S.Boobalan[1], M.Kalaimani[2], Karthikeyan.L.M[3*]

[1]Department of Textile Technology, Karpagam University, Coimbatore, India; [2]Department of Textile Processing, GRG Polytechnic College, Coimbatore, India, [3]Department of Aeronautical Engineering, Techno Global University, Shillong, India

Manuscript received 05th March, 2015, revised 21st April, 2015, accepted 10th May, 2015

Abstract

Eco-friendly textiles are those textile products which do not contain any hazardous or toxic substance and are biologically degradable, so that they do not cause any damage to the environment. The Asian countries like India have a rich heritage and tradition of using natural dyes obtained from natural sources, as they are eco-friendly for textile products. However, after the discovery of synthetic dyes a steady decline in the use natural dyes has been noticed. The introduction of synthetic caused health hazards as well as environmental pollution. Hence textile colourists have started using natural dyes for colouring fabrics. These natural dyes exhibit better bio degradability and have better compatibility with the environment. In this colouring work, we have used the fruits of Prickly Pear (*Opuntia catcus*) as natural dye. Fruits of prickly pear as natural dye which are available plenty in India, can be used as ecofriendly textile product. This material has been evaluated to find the effects of biodegradability and compatibility with environment in textile industries. Prickly pear fruits are crushed and then alum and turmeric as mordants are mixed with it. Different kind of fabrics such as cotton, wool and polyester were coloured. The colored fabrics have been tested for chemical and physical characteristics.

.

Keywords: Biodegradability, Colouring, Dyeing, Mordants, *Opuntia catcus*

Abbreviations used

C: Celsius	VG: Very Good	MO: Moderate	Sq: Square
EX: Excellent	GO: Good	lbs: Pounds	

1. Introduction

The discovery of man-made synthetic dyes in the mid of 19th century triggered the end of the large-scale market for natural dyes. Saxena and Raja[1] indicated various types of dyes, their origins, chemistry, production techniques, advantages, drawbacks and their applications for textile technology. Most of the natural dyes are colorants from plant sources like mots, berries, bark, leaves and wood and other organic sources such as fungi and lichens. Samanta and Agarwal[2] report the biochemical analysis of natural dyes available in different types of natural sources.

**Corresponding author*
Full Address :
Department of Aeronautical Engineering, Techno Global University, Shillong-793003, India
Phone no. +91 9865547716
E-mail: mklarthikeyan@yahoo.in

Plant-based dyes such as indigo, saffron and madder were raised commercially and were important trade goods in the economies of Asia and Europe. Ali and El-Mohamedy[3] explained the natural dye extracted from prickly pear for wool with various mordents. Jothi[4] explained the method of extracting pigments from African marigold flower for textile application. Gokhale et al.[5] have studied the cotton dyeing with natural dye extracted from pomegranate peel and the processing, stability and application of this pigment also have been analyzed. Indian textile exports have resorted to the use of natural dyes. Siva[6] mentioned that more than 450 dye-yielding plants are available in India. So far the green minded consumer, due to significant awareness of the people about the eco-friendly of various dyes and chemicals, it is essential to study the possibility of extent of application of natural dyes which can be used to a maximum extent to discharge our duties and responsibilities to build on eco-friendly. In this work, the

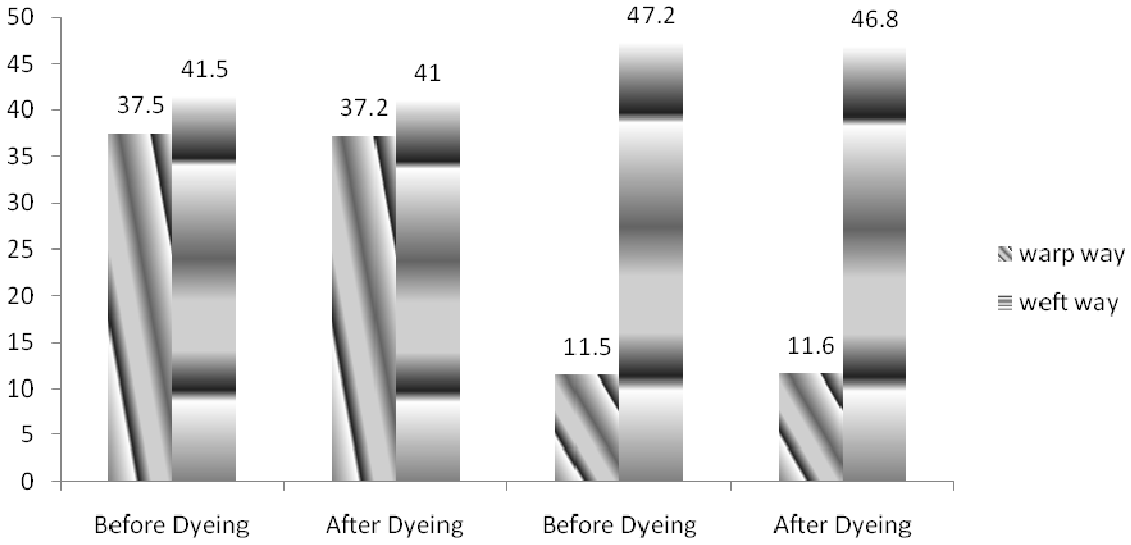

Figure I. Effect of dyeing on fabric tensile strength in lbs

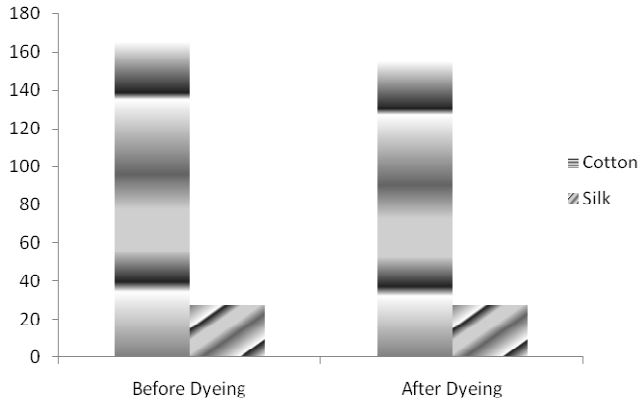

Figure II. Effect of dyeing on fabric bursting strength in lbs/sq. inch

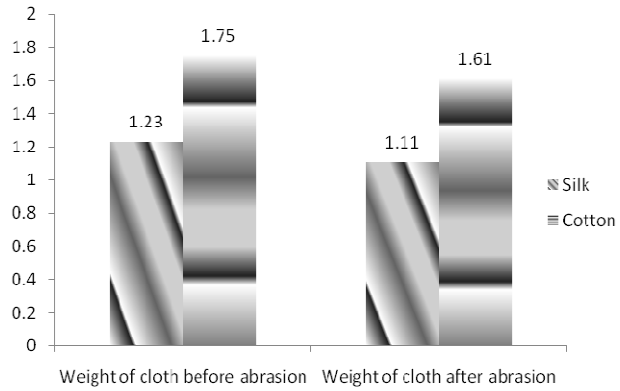

Figure III. Effect of dyeing on fabric abrasion in

dyed fabrics like cotton, silk, wool and polyester have been treated using the natural dye which is botanically named as '*Opuntia cactus*', commercially named as Prickly Pear and in Tamil language it is known as sappathikalli.

2. Preparation of Natural Dye Solution

Main source of natural dyes are vegetables, animals and minerals. Bechtold and his collegues[7] have mentioned the methods of extracting yellow and red colours for textile dyeing from wastage of foods and beverage industries. Singh and Purohit[8] explained the applications of natural dyes using natural with chemical mordants for wools. Chengaiah and his team[9] discussed the medical importance of natural dyes. The natural dyes from Prickly Pear are eco-friendly as naturally dyed materials have good resistance to cloth invasion.

The standard procedure for the preparation and application of the plant extract is as follows: Different plant parts free from diseases are selected. When storing the plant paste for future usage it is made sure that they are dried and stored in an airy container. While selecting utensils for the extract preparation all utensils should be properly cleaned. Plant extract should be placed out of reach of children and common living environmental area. Productive clothing can be worn while applying the extract if necessary. After handling the plant extract, hands should be washed. Initially the fruits of *Opuntia catcus* were crushed & seeds were removed. The crushed fruits were then mixed with sufficient quantity of water & heated up to 70°C. It was then cooled & used as dye extract. Alum and Turmeric were used as mordant. The alum and Turmeric powders were separately mixed with water and the bath was setup then the materials were entered into the bath and worked for 10 to 15 minutes. Then the material was taken and washed with cold water.

3. Results and Discussion

The dyeing process was carried out at four different temperatures (40°C, 60°C, 80°C and 100°C) on all fabrics with alum and turmeric as mordants. The effect of temperature was studied for tensile strength, bursting strength, abrasion and stiffness. The colour was well for cotton and silk at 60°C and 100°C but the colour was not fixed for polyester & wool. The properties of cotton and silk have been shown in **Figure I** to **V** and in **Table I** to

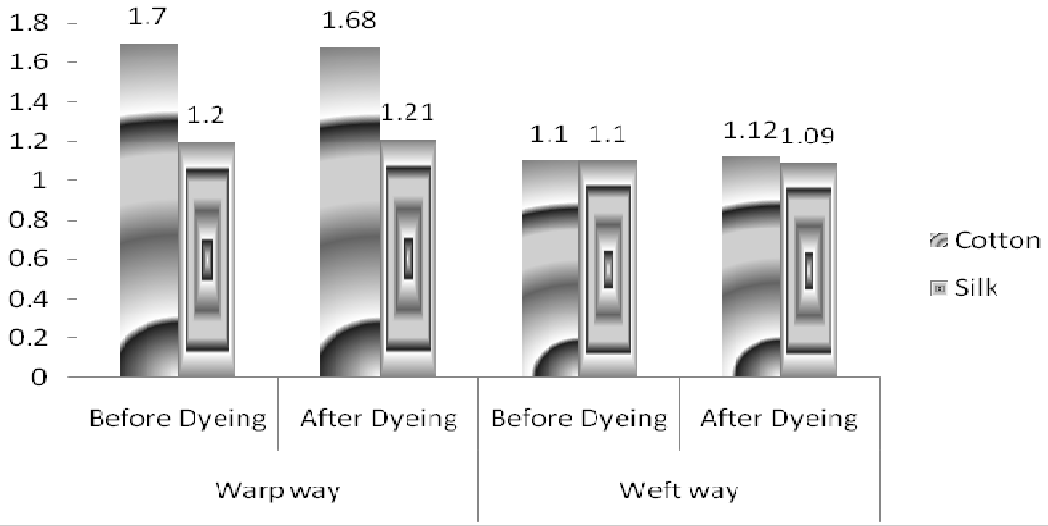

Figure IV. Tensile properties of printed cotton in lbs

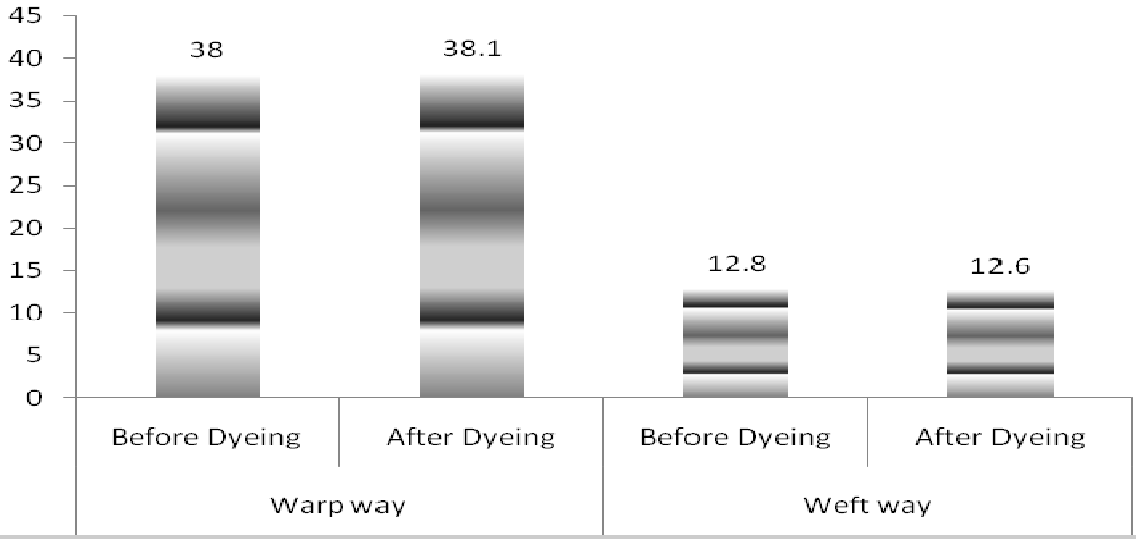

Figure V. Tensile properties of printed cotton in lbs

Table I. Effect of mordants on cotton: fastness properties

Sl. No	Mordants	Wash Fastness		Dry Rubbing		Wet Rubbing		Perspiration acids		Perspiration alkaline	
		Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining
1	Alum	VG	VG	EX	VG	VG	GO	VG	EX	VG	GO
2	Turmeric	VG	GO	VG	VG	VG	VG	VG	VG	VG	GO

When the pigment is applied to cotton,

- It has moderate fastness to washing
- It has good fastness to dry rubbing & moderate fastness to wet rubbing
- It has good fastness to perspiration in acid condition& moderate fastness to perspiration in alkaline condition.

Table II. Effect of mordants on silk : fastness properties

Sl. No	Mordants	Wash Fastness		Dry Rubbing		Wet Rubbing		Perspiration acids		Perspiration alkaline	
		Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining
1	Alum	EX	VG	EX	EX	VG	VG	VG	GO	GO	VG
2	Turmeric	EX	EX	EX	VG	VG	VG	GO	VG	VG	EX

When the pigment is applied to silk,

- It has moderate fastness to washing
- It has good fastness to dry rubbing & moderate fastness to wet rubbing
- It has good fastness to perspiration in acid condition& moderate fastness to perspiration in alkaline condition.

Table III. Effect of dyeing on fabric (lbs)

Sl.No.	Fabric	Tensile strength				Stiffness			
		Warp Way		Weft Way		Warp Way		Weft Way	
		Before Dyeing	After Dyeing	Before Dyeing	After Dyeing	Before Dyeing	After Dyeing	Before Dyeing	After Dyeing
1	Cotton	37.5	37.2	11.5	11.6	1.7	1.68	1.1	1.12
2	Silk	41.5	41.0	47.2	46.8	1.2	1.21	1.1	1.09

It has been noticed that,

- In case of cotton there is no appreciable loss of tensile strength.
- After dyeing, the stiffness properties do not vary much for both in cotton and silk.

Table IV. Effect of dyeing on fabric bursting strength & abrasion

Fabric	Bursting Strength (lbs / Sq.inch)		Weight of cloth on abrasion (grams)		Percentage loss	
	Before Dyeing	After Dyeing	Before abrasion	After abrasion	Loss in Bursting strength	Loss in weight on abrasion
Cotton	165	155	1.75	1.61	6.06%	4.0%
Silk	27.5	27.3	1.23	1.11	0.72%	9.7%

It has been noticed that,

- In the case of silk no loss in bursting strength after dyeing, but in case of cotton, strength loss is noticed after dyeing
- The percentage loss of weight due to abrasion is 9.7% in case of silk and the same is 4% in case of cotton

Table V. Fastness properties of printed cotton

Wash Fastness		Dry Rubbing		Wet Rubbing		Perspiration acids		Perspiration alkaline	
Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining	Change in colour	Change in staining
EX	VG	EX	EX	VG	VG	GO	MO	GO	GO

- It has noticed that, the printed cotton material has very good fastness to washing & rubbing & moderate fastness to perspiration.

Table VI. Tensile properties and Bursting strength of printed cotton

Sl.No.	Tensile properties (lbs)				Bursting strength (lbs/Sq.inch)	
	Warp way		Weft way			
	Before Dyeing	After Dyeing	Before Dyeing	After Dyeing	Before dyeing	After dyeing
1	38.0	38.1	12.8	12.6	160	159

- In case of printed cotton no significant loss in tensile strength is noticed
- Percentage loss in bursting strength is 0.625.
- In case of printed no loss in bursting strength is noticed.

VI.

The results indicate that the selected dye was more suitable for cotton and silks with the following advantages. It has moderate fastness to washing. It has good fastness to dry rubbing & moderate fastness to wet rubbing. It has good fastness to perspiration in acid condition & moderate fastness to perspiration in alkaline condition. It has fastness to dry rubbing & moderate fastness to wet rubbing. It has moderate fastness to perspiration both in alkaline & acid condition. There is no appreciable loss of strength both in warp way and wept way. In the case of silk no loss in bursting strength is noticed after dyeing. In the case of cotton strength loss is noticed after dyeing. The percentage loss of weight due to abrasion is 9.7% in case of silk & 4% in case of cotton. The stiffness properties do not vary much after dyeing both in cotton silk. The printed cotton material has very good fastness to washing & rubbing & moderate fastness to perspiration. In case of printed cotton no significant loss in tensile strength is noticed. In case of printed fabrics no loss in bursting strength is noticed.

Conclusion

Making consumers aware of the environment problems caused by synthetically dyed textile and making an alternative which is widely available are the keys to the success of natural dye. Developing countries are trying to use natural dye for the value added textile because of the low labour wages. Natural dyes are dyestuffs made from flowers, plants and the major source of natural colourants is plants used for extracting colour components. Natural dyeing techniques are preserved by artisans in traditional cultures around the world. The concept of eco-friendly textiles is giving momentum in the present of ecological

concern. The discovery of side effect of synthetic dyes has generated entropy in the system. This paper indicates the possibilities of effective usage of Prickly Pear to make pigments for cotton and silks. The results obtained from the pigments indicate the special futures of this plant for colouring solutions in various textile applications.

Conflict of interest

The author' s declares none.

References

1. Saxena S & Raja ASM. Natural Dyes: Sources, Chemistry, Application and Sustainability Issues, In Muthu SS ed. *Textile Science and Clothing Technology*, 2014; pp 37-80.
2. Samanta AK & Agarwal P. Application of natural dyes on textiles, *Indian Journal of Fibre and Textile Research.* 2009; **34:** 384-399.
3. Ali NF & El-Mohamedy RSR, Eco-friendly and protective natural dye from red prickly pear (Opuntia Lasiacantha Pfeiffer) plant, *Journal of Saudi Chemical Society*. 2011; **15 (3):** 257–261.
4. Jothi D. Extraction of natural dyes from African marigold flower (Tagetes ereecta L) for textile coloration. *AUTEX Research Journal*. 2008; **8 (2):** 49-53.
5. Kulkarni SS, Gokhale AV, Bodake UM, & Pathade GR. Cotton Dyeing with Natural Dye Extracted from Pomegranate (Punica granatum) Peel, *Universal Journal of Environmental Research and Technology*. 2011; **1 (2):** 135-139.
6. Siva R, Status of natural dyes and dye-yielding plants in India, *Current Science*. 2007; **92 (7):** 916–925.
7. Bechtold T, Mussak R, Mahmud-Ali A, Ganglberger E & Geissler S, Extraction of natural dyes for textile dyeing from coloured plant wastes released from the food and beverage industry, *Journal of the Science of Food and Agriculture*. 2006; **86 (2):** 233–242.
8. Singh SV & Purohit MC, Applications of Eco-Friendly Natural Dye on Wool Fibers Using Combination of Natural and Chemical Mordants, *Universal Journal of Environmental Research and Technology*. 2012; **2 (2):** 48-55.
9. Chengaiah B, Rao KM, Mahesh Kumar K, Alagu Sundaram M, & Madhusudhana Chetty C, Medicinal Importance of Natural Dyes - A Review, *International Journal of PharmTech Research*. 2010; **2 (1):** 144-154.