PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 43(2): 185-188 (2013)
DOI: 10.31901/24566608.2013/43.2.09

Effect of Enzymes and Swelling Agents on Colour Strength (K/S) Property of *Khadi* Cotton Fabric Dyed With Sandalwood Dye: An Eco-friendly Approach

Sunita Dixit[*] and Shahnaz Jahan[**]

[*]Department of Clothing and Textiles, Faculty of Home Science, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India
[**]Department of Clothing and Textiles, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

KEYWORDS Acid Cellulase. Ethylenediamine. Neutral Cellulase. Sodium Hydroxide. Zinc Chloride

ABSTRACT Cellulase and swelling agents are known to be effective in improving the colour strength of cotton. Nowadays, the handloom fabrics are much preferred due to development of innovative designs and their comfort in wearing. Interests in natural dyes are also growing throughout the world and people are becoming more aware of the need for eco-friendly materials to come up and dominate the harmful synthetic dyes. But, *khadi* cotton has some major shortcomings like less dyeability. Keeping in view that the pretreatment of khadi cotton with cellulases, swelling agents and combination of cellulases and swelling agents before dyeing improves the colour strength properties, the present study was planned. It was found that for all the enzyme treated (acid and neutral cellulase) as well as swelling agents treated (Sodium hydroxide, Ethylenediamine and Zinc chloride) samples, the colour strength was increased in comparison to the untreated samples

INTRODUCTION

Cotton is produced in over 50 countries worldwide, averaging 20-24 million tons per year. India is one of the largest consumers of cotton, accounting for about 60% of the total consumption of cotton (Furter et al. 2007).

Cotton, whether present as fibre, yarn or fabric, requires some form of pre- treatment to make it suitable for dyeing and finishing. The basic function of pre- treatment is to impart uniform and good absorbency and whiteness without chemically damaging cotton. The natural impurities in cotton are pectin, protein, wax and minerals, whereas added impurities could be lubricating oils, sizes etc. In recent years efforts are being made to develop a mild and environment friendly process. Thus, enzymatic pre treatment has assumed more importance due to present concern of clean and eco-friendly environment.

The preparation processes of cotton textiles include singeing, desizing, scouring, bleaching and mercerization. These treatments remove natural and human induced impurities, that is, non-cellulosic constituents and other unwanted substances and increase the affinity of cellulose for dyes and finishes. In addition, colour enhancement can be accomplished through the treatment of cotton with cellulase enzymes either before or after dyeing. The increased enhancement occurs because of the removal of fibers, which give the surface of cotton fabric a frosted appearance (Lewin 2007).

Swelling agents, primarily strong electrolytic solvents have been employed to pretreat cellulose. Two types of swelling agents are known one is intercrystalline and the other intracrystalline. For example, water can penetrate and loosen only the amorphous region of cellulose; this is considered as an intercrystalline swelling agent. On the other hand, swelling agents, such as certain salts and alkaline solutions, affect both the amorphous and crystalline regions of cellulose; they are called intracrystalline swelling agents. In other words, intracrystalline swelling agents are effective in loosening the crystalline region of cellulose. The action of swelling agents inherits the outer skin on cotton fibers and causes it to split and form collars; the inner cellulose layers swell rapidly the collars (Fan et al. 1987). Due to loosening of crystalline region of cellulose by swelling agents, the absorbency of the fabric towards water and dyes is increased.

Therefore, keeping in view that the pretreatment of *khadi* cotton with cellulases, swelling agents and combination of cellulases and swelling agents before dyeing improves the colour strength and colourfastness properties, the present study was planned.

MATERIAL AND METHODS

Specification of Test Sample

Pure white *khadi* cotton fabric was procured from "Gandhi Ashram" of local market in Pant-

nagar (Uttarakhand). The fabric specifications, that is, the fabric count, weight per unit area and thickness of the chosen material for the study was calculated. The specifications of the fabric are given in Table 1.

Table: 1 Specifications of the khadi cotton fabric used in the present study

Fabric count (warp/filling)	*Weight per unit area(g/m²)*	*Fabric thickness(mm)*
27/18	157	0.55

Experiments were conducted to determine optimum values of four variables for acid and neutral cellulase enzyme treatment, namely, pH, concentration, treatment time and temperature. Concentration, treatment time and temperature were the three variables optimized for the swelling agents. Dyeing variables, that is, concentration of dye material, extraction time, dyeing time, mordant concentration and method of mordanting with natural and metallic mordants were optimized. Mordanting is a process in which a mordant is used and it is capable of intensifying or deepening the dyeing process.

Colour Measurement of Dyed Samples

The principle involved in colour measurement is to project specific light on a sample and measure the reflectance of light from it. The colour instrument consists of two parts: first optical sensor and second signal processor. The optical sensor measures the reflectance of sample at different wavelength. The optical sensor may be a spectrophotometer. The reflected light is converted to photocurrent and is passed to signal processor acquisition of colour parameters. The Kubelka Munk theory makes it possible to predict the colour recipe.

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

in which R is the reflected light at wavelength λ,

K is the coefficient of scattering at λ,

S is the coefficient of absorption of the dye at λ.

The colour strength (K/S) values were determined using Gretag Macbeth Color Eye 7000A. The samples were folded twice and placed at the eye of the instrument and light was passed. The reflectance was displayed on the computer screen. Each sample was oriented twice by reversing the direction of the specimen to the light. The K/S values were noted down directly from the computer screen (Mehta and Bhardwaj 1998).

RESULTS AND DISCUSSION

Dyeing of Samples Treated With Enzymes and Swelling Agents

The *khadi* cotton samples were treated with optimized conditions of enzymes and swelling agents. The optimum pH, concentration, treatment time and temperature selected for the acid cellulase enzyme treatment were 5.5, 1.5% (owf), 45 minutes and 50°C, respectively whereas in case of neutral cellulase enzyme, it was 7.5, 2.0% (owf), 70 minutes and 70°C respectively. The optimum concentration, treatment time and temperature selected for sodium hydroxide treatment were 20% w/v, 60 minutes and 60°C, respectively. In case of ethylenediamine, 80% w/v, 60 minutes and 70°C were selected as optimum concentration, treatment time and temperature, respectively. In case of zinc chloride treatment, the optimum concentration, treatment time and temperature were selected as 80% w/v, 60 minutes and 70°C.

5 g sandalwood dye extracted for 90 minutes gave best results on *khadi* cotton when dyeing was carried out for 75 minutes. In case of sandalwood dye 0.05 g each of alum and tartaric acid with pre-mordanting, 5 g of *babool* bark with simultaneous mordanting and dyeing and 5 g pomegranate rind with postmordanting were found to produce best results.

The dyeing of untreated as well as treated samples was carried out with sandalwood dye. On the basis of colour strength (K/S), the comparisons were made between the treated and untreated dyed cotton samples.

Colour Strength (K/S) of Treated Khadi Cotton Fabric Dyed with Sandalwood Dye

In case of sandalwood dye, higher colour depth was shown by alum (3.194) than tartaric acid (2.943) in case of metallic mordants as shown in Table 2, whereas pomegranate rind (2.345) exhibited more depth in dyeing than *babool* bark (2.126) in case of natural mordants.

In case of Sandalwood dye (Table 2) the K/S values of acid cellulase enzyme treated samples, without mordant, mordanted with *babool* bark,

Table 2: Colour strength (K/S) of cellulases and swelling agents treated samples dyed with sandalwood dye

Samples	*Without mordant (K/S)*	*Babool (K/S)*	*Pomegranate (K/S)*	*Alum (K/S)*	*Tartaric acid (K/S)*
Untreated	1.767	2.126	2.345	3.194	2.943
Acid cellulase	1.937 (8.77)	2.643 (19.56)	2.997 (21.75)	4.341 (26.42)	3.952 (25.53)
Neutral cellulase	2.013 (12.22)	2.796 (23.96)	3.133 (25.15)	4.487 (28.81)	4.116 (28.49)
Sodium hydroxide	1.983 (10.89)	2.684 (20.78)	2.992 (21.62)	4.378 (27.04)	3.989 (26.22)
Ethylenediamine	1.885 (6.25)	2.443 (12.97)	2.759 (16.05)	4.264 (25.09)	3.814 (22.83)
Zinc chloride	1.805 (2.10)	2.325 (8.55)	2.688 (12.10)	4.175 (23.49)	3.773 (21.99)
Sodium hydroxide + Acid cellulase	2.123 (16.76) (8.76a)	2.956 (28.07) (10.58a)	3.338 (29.74) (6.14a)	4.689 (31.88) (4.30a)	(32.18) (5.16a)
Ethylenediamine + Acid cellulase	2.121 (11.97) (8.67a)	2.873 (26.00) (8.00a)	3.247 (27.77) (3.51a)	4.678 (31.72) (4.08a)	4.231 (30.44) (2.71a)
Zinc chloride +Acid cellulase	1.993 (11.33) (2.80a)	2.735 (22.26) (3.36a)	3.239 (27.60) (3.27a)	4.542 (27.67) (1.21a)	4.167 (27.37) (1.22a)
Sodium hydroxide + Neutral cellulase	2.371 (22.19) (15.09b)	3.215 (33.87) (13.06b)	3.494 (32.88) (10.33b) (38.81)	5.220 (14.04b)	4.893 (39.85) (15.87b)
Ethylenediamine + Neutral cellulase	2.205 (19.86) (8.70b)	3.124 (31.94) (10.49b)	3.364) (30.29) (6.86b)	5.103 (37.40) (12.07b)	4.734 (37.83) (13.05b)
Zinc chloride + Neutral cellulase	2.177 (18.83) (7.53b)	3.006 (29.27) (6.98b)	3.272 (28.33) (4.24b)	4.898 (34.78) (8.39b)	4.529 (35.01) (9.69b)

1. Figures in parenthesis indicate percentage increase in colour strength of treated samples in comparison with untreated samples.
2. Figures in parenthesis with subscript letter a and b indicate percentage increase in colour strength of treated samples in comparison of acid and neutral cellulase treatment, respectively.

pomegranate rind, alum and tartaric acid were found as 1.937, 2.643, 2.997, 4.341 and 3.952, respectively, whereas the K/S values in case of neutral enzyme, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were 2.013, 2.796, 3.133, 4.487 and 4.116 respectively.

The colour strength (K/S) of three swelling agents treated samples and dyed with sandalwood dye is given in Table 2. It was found that maximum K/S was shown by sodium hydroxide followed by ethylenediamine and zinc chloride treated samples. The K/S value of sodium hydroxide treated samples, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric were 1.983, 2.684, 2.993, 4.378 and 3.989 respectively. The K/S value of ethylenediamine treated samples, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric were found to be 1.885, 2.443, 2.759, 4.264 and 3.814, respectively. The K/S value of zinc chloride treated samples, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric were observed as 1.805, 2.325, 2.688, 4.175 and 3.773, respectively.

Table 2 also reveals that in case of sandalwood dye the K/S of Sodium hydroxide treated samples followed by acid cellulase enzyme treatment, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were 2.123, 2.956, 3.338, 4.689 and 4.340, respectively. The K/S of Ethylenediamine treated samples followed by acid cellulase enzyme treatment, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were observed as 2.121, 2.873, 3.247, 4.678 and 4.231, respectively whereas the K/S of zinc chloride treated samples followed by acid cellulase enzyme treatment, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were found to be 2.121, 2.873, 3.247, 4.678 and 4.231, respectively. The K/S value of sodium hydroxide treated samples followed by neutral cellulase enzyme, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were 2.731, 3.215, 3.494, 5.220 and 4.893, respectively. The K/S value of ethyl-

enediamine treated samples followed by neutral cellulase enzyme, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were found as 2.205, 3.124, 3.364, 5.103 and 4.734, respectively. The K/S value of zinc chloride treated samples followed by neutral cellulase enzyme, without mordant, mordanted with *babool* bark, pomegranate rind, alum and tartaric acid were observed as 2.177, 3.006, 3.272, 4.898 and 4.529, respectively. The swelling agents treated samples followed by neutral cellulase enzyme treatment showed higher depth in dyeing than acid cellulase enzyme treatment.

CONCLUSION

It was found that for all the enzyme treated (acid and neutral cellulase) as well as swelling agents treated (Sodium hydroxide, Ethylenediamine and Zinc chloride) samples, the colour strength was increased in comparison to the untreated samples. Among the three swelling agents, Sodium hydroxide treated sample obtained the highest colour strength (K/S) followed by Ethylenediamine and Zinc chloride treated samples. The K/S values of cellulase treated samples were enhanced in comparison with untreated samples. However, higher depth of dyeing was exhibited by neutral cellulase enzyme than acid cellulase enzyme treated samples. The swelling agent treatment followed by cellulase enzyme treatment showed higher depth in colour values. The maximum swelling caused by the sodium hydroxide followed by cellulase enzyme treatment gave higher K/S value than ethylenediamine and zinc chloride treated samples followed by cellulase treatment. The swelling agents treated samples followed by neutral cellulase enzyme treatment showed higher depth of dyeing than acid cellulase enzyme treatment.

The information generated from the study is very useful for the agriculturists, cotton manufacturers, *khadi* industry, textile finishers and consumers. The textile finishers can safely apply these finishes to khadi to improve colour strength and colour fastness properties without altering their mechanical properties.

REFERENCES

Fan LT, Gharpurag MM, Lee YH 1987. *Biotechnology Monograph: Cellulose Hydrolysis.* New York, Springer Verlag, Berlin, Volume 6, pp. 14-17, 66.

Furter R, Ghorashi H, Schleth A 2007. The role of cotton classification in the textile industry. *Asian Textile Journal*, 16(5): 67.

Lewin M 2007. *Handbook of Fiber Chemistry*. 3rd Edition. United States of America: CRC Press, Taylor & Francis Group.

Mehta PV, Bhardwaj SK 1998. *Managing Quality in the Apparel Industry*. New Delhi: New Age International Publishers.