ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

COLOUR FASTNESS PROPERTIES OF MORDANTS AND MORDANTING METHODS WHEN DYED WITH USED TEA LEAVES ON SILK FABRIC

Afrose Fathima Farid

Assistant Professor, Department of Post Graduate Studies and Research in Home Science – Textile Science and Fashion Designing, Justice Basheer Ahmed Sayeed College for Women, Chennai – 600018,India.

ABSTRACT

Awareness about environmental concerns and ill effects on health caused by synthetic dyes has made the natural dyes comeback. Many natural materials from plant and animal sources are being identified as possible colourants, one such established colorant is tea leaves. Tea is primarily consumed in large quantity as a beverage all over the world. The reused tea dust as a colourant was explored in this study and its fastness property of silk fabric under different mordanting methods and mordants was evaluated. It was observed that the reused tea leaves contained colourants but more effort was involved in the extraction of dye to obtaining the required shade. The post mordanting method was found to have better colour fastness and visual properties. Potassium dichromate and alum significantly improved the fastness properties of the dyed samples.

KEYWORDS: Colour fastness, Mordants, Mordanting Methods, Natural dye, Silk fabric, Used Tea leaves.

INTRODUCTION

Colours are fascinating and add beauty to our world. Mans quest for beauty led to the discovery of colouring matter from natural sources such as plants and animals. Till the invention of mauve by William H. Perkins in 1856, natural colourants were the only source of colour known to man. The onset of synthetic dyes replaced the natural dyes. Now due to the awareness about health, safety and ecological benefits of the natural dyes it has slowly been making a comeback.

Natural Dyes

Natural colourants can be extracted from leaves, fruits, seed, flowers, barks and roots of plants, insects, fungus, bacteria, lecithin and some micro organisms. Some of the popular natural colourant studied by researchers are *madder* (Guinot et.al. and Saidman et.al.), *henna* (Sing et.al.,Agarwalet.al. and Gulrajani et.al.), *weld* (Cristea et.al. and Nateri et.al.), *indigo, tyrian purple* (Korenand Son et.al.), *annatto, saffron* (Tsatsaroni et.al.), *red sandle wood* (Gulrajani et.al., Dwivedi et.al. and Benenecia&Courreger), *sappan wood* (Xu& Song), *mariegold* (Samanta et.al., Sarkar et.al. and Deo&Paul *), babool, manjistha* (Gilani et.al.), *eucalyptus hybrid seed* (Dayal&Dobhal), *seed of cassia tora, grewiaoptiva, gomphrenaglobosa* (Shankar &Vankar), *neem bark* (Mathur et.al.), *mimusopselengi, terminaliaarjun, pomagranite rind* (Bhattacharya et.al. and Patel &Agarwal), *morindaangustifoliaroxb* (Bhujan et.al.*), ginger rhizome* (Popoola et.al.*), artocarpushetrophyllus* (Khan et.al.), *jatrophacurcas seed* (Radhika& Jacob and Mondhe&Rao), *cutch, ratanjot* (Khan et.al.*), hinjal, jujube bark* (Maulik et.al.) *coffee seed* (Teli and Paul), *jackfruit wood, deodar leaf, eucalyptus leaf* (Pan et.al. and Ali et.al.), *wattle bark* (Verma& Gupta), *chrysanthemum flower* (Saxena et.al.), *eucalyptus bark* (Vankar et.al.), *Teak leaves* (Nanda et.al.), *grape skin waste* (Raja et.al.), *euphorbia leaves* (Dixit &Jahan), *areca catechu nut* (Sudhakar et.al.), *beet sugar* (Mathur et.al.), *tulsi leaves*(Patel et.al.*),tea (*Chan et.al., Deo& Desai and Kaur& Sharma*), turmeric* (Chavan and Chakraborthy), *goldendrop root* (Bains et.al.), *palash, saw dust, alroot, garan wood, kesuda,* (Mohanty et.al.), *terminillaarjun fruit, chochineal* (Kamel et.al.), *onion skin, kimora root* (Neetu&Shahnaz),*lantana, hamelia, kilmora, walnut (*Srivastava et.al.), *hododendron arboretum* (Sati et.al.), *lac* (Mishra et.al.), *old fustic, persian berries* (Padfield&Landi),*log wood, juglone*(Gupta), *water lily root* (Duff et.al.), *acalypha*(Mahale et.al.), *cutch, ratanjot* (Khan et.al.), *quercusinfectorria, rubiacordfolia, rumexmaritimus* (Singh et.al.), *chelidoniummajus* (Kamel et.al.), *gallnut* (Shahid et.al. and Lee et.al.), *fruit of opuntiaficus-indica*(Guesmi et.al.),*woad* (Cristea et.al.), *sunmac, oak* (Inan et.al.), *coreopsis* (Haar et.al.), *sumac* (Kumbasar et.al.), *chinese cork tree, gromwell, cochineal* (Wakida et.al.), *flossophore* (Wang et.al.), *kermes, orseilline* (Das), *monascorubrin* (Liu &Bai), *osage orange* (Sarkar& Seal), *caesalpina, bougainvillea, goldenrod, parijata, suntberry, pivet, alder, rofblamala, custard apple, caesalpina, balsam, black berries, canna, lily, nettles, dahlia* (Vankar), *lodh* (Singh and Purohit) *thermomyces fungus* (Poorniammal et.al.), *swieteniamahagoni* (Haque et.al.),*jamun, amar stem* (Jain) and organisms like *cassia augustifolia, peltaphorumferrugeum, bixaornella, jatrophacurcas, ganodermalucidum, coriolusversicolour, amanita muscaria and monascusruber* (Bhargava&Jahan).

Mordants

Most of the natural dyes do not have natural affinity for textile fibers and hence require a chemical or a catalyst to make the colour permanent called a mordant. Some of the common mordants are saliva, urine, turmeric, lemon juice, banana flower, tamarind kernel powder, tulsi leaves, myrobolan, multhanimitti, tannins, alum, iron, crome, tin and copper, stannous chloride, stannic chloride, ferrous sulphate, copper sulphate, potassium dichromate, aluminium sulphate, sodium potash tartarate, zinc chloride to name a few Vankar (2001), Samanta A.K. and Agarwal (2009).

Mordanting Methods

There are three stages when the material to be dyed with natural dyes can be mordantedie., before dyeing (pre-mordanting), during dyeing (simultaneous) and post dyeing (post mordanting). All of them have their own quirks. In addition to improved dye uptake and colour fastness, a wide range of shades, tints and hues can be obtained with different mordants and mordanting methods (Samanta and Agarwal, 2009).

Advantages and Disadvantages of Natural Dyes

Natural dyes are less toxic, less polluting, less health hazardous, non poisonous and non-carcinogenic. They produce harmonizing colours and create gently, soft, subtle and restful effect. They are environment friendly and can be recycled after use. Although natural dyes have several advantages, there are some limitations as well. Tedious extraction of colouring component from the raw materials, low colour value and longer time makes the cost of dyeing with natural products higher. These were some of the reasons for synthetic dyes being preferred. Environmental concerns against synthetic dyes have prompted the revival of natural dyes. However, in view of polluting aspects of synthetic dyes and long term non sustainable nature of these petrochemicals derivatives, natural dyes are increasingly favoured all over the world (Barghava and Jahan, 2013).

Tea

Tea is the favourite beverage of the Indians and favoured by many all over the world. This refreshing beverage comes from a plant called “Camellia Sinesis” and ‘Catechin’ a polyphenol present in the tea leaves is the colourant. Tea as a colourant has been studied by Deo& Desai (1999), Chan et.al. (2000), Teli et.al. (2002) andKaur& Sharma (2015). While, making tea at Indian homes in the traditional way, tea powder or dust is boiled in water and then filtered. The filtered liquid is used to prepare the aromatic tea while, the dust is discarded. The discarded leaves still contains the colorant, which is usually not fully exhausted in the tea making process.

Objective of the study

So far no study has been done on the reuse of tea powder. Hence, this study was undertaken to study the colourant produced from used tea powder on silk fabric and the changes caused in their shade due to various mordants and mordanting methods.

MATERIALS AND METHODS

Material

Bleached, sized silk plain weave white fabric was used for the study. The silk yarns were of 19/21 Denier filature, 2 ply & 4 ply twist for warp and weftrespectively was used in the fabric construction. The tea used in the study was Brook Bond TajMahal tea manufactured by Hindustan lever Ltd. at 20% dye shade concentration. The mordants alum 15%, myrobalan 20%, ferrous sulphate 5%, potassium di-chrome 5% and tannic acid 5% concentrations were used.

Dye Extract preparation

The tea powder after boiling once (to mimic the traditional tea making process) was strained and dried in shade. The collected tea powder was soaked overnight in 100 ml of cold water and then boiled for 30 minutes. The liquid was strained and the extract was mixed with water to form the 20% shade concentration. This dye concentrate was used for dyeing.

ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

Dyeing Procedure
The fabric samples were subject to one of the following mordanting process:
Pre – [Soaping – Mordanting – Dyeing – Soaping – Rinsing and Drying]
Simultaneous – [Soaping –Mordanting and Dyeing – Soaping – Rinsing and Drying]

Post – [Soaping – Dyeing – Rinsing – Mordanting – Soaping – Rinsing and Drying]

Experiments
The influence of the mordants and mordanting methods on the colour of the dyed fabrics in terms of depth of shade, evenness of colour, texture and general appearance was analysed. Colour fastness test to water, sunlight, hot & cold laundering, wet & dry pressing, acid & alkaline perspiration and wet & cry crocking was rated in terms of colour change and colour transfer properties using British Standard Grey Scale with the aid of Gretag Macbeth Spectrolight – III.

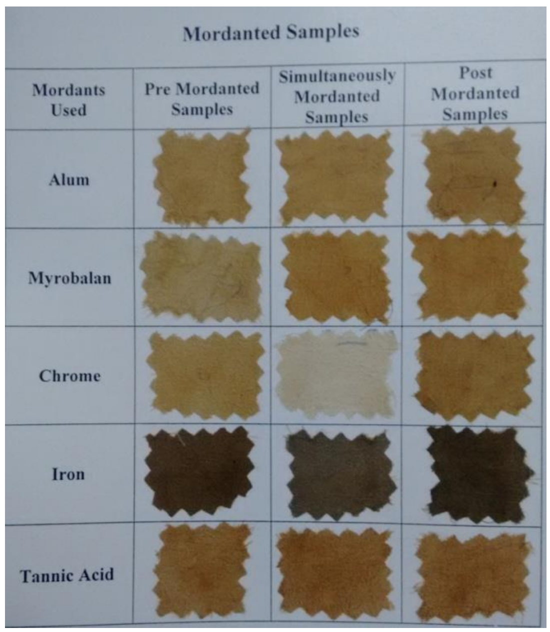

FIGURE 1 – REUSED TEA DUST DYED AND MORDANTED SILK SAMPLES

RESULTS AND DISCUSSION
The reused tea dyed samples and the 15 shade variations obtained due to the different mordants and mordanting methods is given in Plate 1. The rating in terms of depth of shade, evenness, general appearance and texture of the fifteen mordanted samples and the unmordanted control sample is given in the Table I.

Visual Inspection
It can be observed that the post mordanted samples had better depth of shade. The crome pre and post mordanted samples showed better depth of shade than the other samples.

The alum and myrobalanmordanted samples were more even in colour when compared to the other samples irrespective of the mordanting method used while, the postmordanted chrome sample was judged to be the best in terms of evenness of colour.

The postmordanted chrome sample had better visual appearance than the other samples. Alum mordanted samples irrespective of the mordanting method had consistently better rating for visual appearance when compared to their counterparts.

TABLE – I - AVERAGE PANEL RATING BY VISUAL INSPECTION

Visual Parameters	Premordanted Samples					Simultaneous Mordanted Samples					Post Mordanted Samples					Unmordanted Control Sample (X)
	1 A	**1 B**	**1 C**	**1 D**	**1 E**	**2 A**	**2 B**	**2 C**	**2 D**	**2 E**	**3 A**	**3 B**	**3 C**	**3 D**	**3 E**	
Depth of Shade	3 – 4	3	5	5	3 - 4	4	4	1	4	4	4	3 - 4	5	4	3 - 4	4
Evenness of Colour	4 – 5	4	4	3 - 4	4	4 – 5	4 – 5	3	3 - 4	4	4	4 - 5	5	3 - 4	3 - 4	4
General Appearance	4	2 - 3	4	3 - 4	3 - 4	4	4	2	3	4	3 - 4	3 - 4	4 - 5	3	3	3 - 4
Texture	3 – 4	3	4 – 5	3 - 4	3 - 4	4	4	3	3	4	3	3 - 4	4	3 - 4	4	4

Fabric Code Key :-	**Guides For Rating Texture :-**	**Guides For Rating :-**
Sample A – Alum Mordant	5 - Very Soft	5 - Excellent
Sample B – Myrobalan Mordant	4 – Soft	4 - Very Good
Sample C – Chrome Mordant	3 - Medium soft	3 - Good
Sample D – Iron Mordant	2 - Low Soft	2 - Fair
Sample E – Tannic Acid Mordant	1 – Rough	1 - Poor

The texture of the samples when compared showed that the tannic acid mordanted samples irrespective of the method of mordanting felt softer than the rest.

Washing Fastness

On laundering at 30^{0}C and 70^{0}C the samples (Table II) in general exhibited no colour change when compared with their respective unwashed control samples except for ferrous sulphate mordanted sample. With regards to colour transference the unmordanted control sample and the pre mordanted samples exhibited better fastness property. Alum and chrome samples irrespective of mordanting method demonstrated better fastness property.

Pressing Fastness

The pressing fastness of the samples given in table II shows that both hot and cold pressing did not alter the colour of the samples. In general all the samples exhibited no colour transfer under dry condition of pressing. Myrobalan and Iron mordanted samples bled colour on hot pressing more than their counterparts. Chrome samples in general exhibited better pressing fastness.

TABLE – II – FASTNESS TO WASHING AND PRESSING

Fabric Code	At 30^0 Centigrade		At 70^0 Centigrade		Wet Pressing		Dry Pressing	
	Colour Change	**Colour Transfer**	**Colour Change**	**Colour Transfer**	**Colour Change**	**Colour Change**	**Colour Change**	**Colour Change**
Pre Mordanted Samples 1 A	5	5	5	5	5	5	5	5
1 B	5	4	5	4	5	5	5	5
1 C	5	5	5	5	5	5	5	5
1 D	3 - 4	4 - 5	4	4 - 5	5	5	5	5
1 E	5	4	5	4	5	5	5	5
Simultaneous Mordanted Samples 2 A	5	5	5	5	5	5	5	5
2 B	5	4	5	3 - 4	5	5	5	5
2 C	5	5	5	5	5	5	5	5
2 D	3 - 4	4 - 5	3	4 - 5	5	5	5	5
2 E	5	3 - 4	5	4	5	5	5	5
Post Mordanted Samples 3 A	5	5	5	3 - 4	5	5	5	5
3 B	5	4	5	3 - 4	5	5	5	5
3 C	5	5	5	5	5	5	5	5
3 D	4 - 5	5	3 - 4	5	5	5	5	5
3 E	5	3 - 4	5	4	5	5	5	5
Control Sample X	5	5	5	5	5	5	5	5

Perspiration Fastness

Simultaneous mordated samples exhibited (Table III) better and consistent fastness under both perspiration conditions. With regards to perspiration fastness, Iron and tannic acid mordanted samples exhibited some colour change under both alkaline and acidic conditions. Myrobalan treated samples fared lower ratings when compared to the rest.

Rub Fastness

From table III it can be understood that post mordanted samples exhibited better rub fastness under dry and wet conditions. The iron mordanted samples had low fastness under both crocking conditions. Crome followed by Alum and tannic acid mordanted samples exhibited good fastness properties with regards to crocking.

TABLE – III – FASTNESS TO PERSPIRATION, CROCKING, SUNLIGHT AND WATER

Fabric Code	**Acid Perspiration**		**Alkaline Perspiration**		**Crocking**		***Sunlight***	***Water***	
	Colour Change	***Colour Transfer***	***Colour Change***	**Colour Transfer**	**Dry Colour Transfer**	**Wet Colour Transfer**	**Colour Change**	**Colour Change**	**Colour Transfer**
Pre Mordanted Samples 1 A	5	4 - 5	5	4	4	3	4	5	4 – 5
1 B	4 – 5	3 - 4	4 - 5	3 - 4	4 - 5	3	4	5	4 – 5
1 C	5	4	5	4 - 5	5	3 – 4	3 - 4	5	4 – 5
1 D	4 – 5	4 - 5	4 - 5	4	4 - 5	2 – 3	3 - 4	4 - 5	4 – 5
1 E	4	3 - 4	4	3	5	4	4	5	4
Simultaneous Mordanted Samples 2 A	5	4 - 5	5	4 - 5	5	4	4	5	4 – 5
2 B	5	4	5	3	5	4	4	5	3 – 4
2 C	4 – 5	5	4 - 5	5	5	5	4	5	5
2 D	4	4	4	4	4 - 5	3	3 - 4	4 - 5	4 – 5
2 E	4	4	5	3	5	4	4	5	3 – 4
Post Mordanted Samples 3 A	5	4 - 5	5	4 - 5	5	4 – 5	4	5	4
3 B	5	3 - 4	5	3	5	4	4	5	3 – 4
3 C	5	4 - 5	5	4 - 5	5	4 – 5	3 - 4	5	4 – 5
3 D	4	4 - 5	4	4 - 5	5	3 – 4	3 - 4	5	4
3 E	5	3 - 4	4 - 5	3 - 4	5	4	4	5	3 – 4
Control Sample X	5	4	5	3 - 4	4 - 5	3 – 4	4	5	3 – 4

Fastness to Sunlight and Water

The colourfastness to sunlight tabulated in Table III shows that the unmordanted sample, alum, myrobalan and tannic acid mordanted samples exhibited better fastness to sunlight. With regards to the fastness to water of the post-mordanted samples were the best with no colour change. While with regards to colour transfer premordanted samples had better ratings. The cromemordanted sample followed by myrobalanmordanted sample fared better than the rest.

CONCLUSION

The reused tea dust contained sufficient colourant to dye the silk fabric samples though more quantity was required to obtain the required colour shade. It was observed that the fastness properties of the unmordanted tea dyed fabric samples improved with the application of mordants. Among the different mordanting methods postmordanted samples were evaluated as very good under visual inspection for all the parameters. The performance in terms of fastness properties of the pre and post mordanted samples was found to be good. The chrome mordanted samples followed by alum mordanted samples exhibited very good fastness and visual properties.

REFERENCES

1. A. Agarwal, A. Garg A and K. Gupta, Colourage, 39, 10, 1992, p.43.
2. S. Ali,N. Nisar and T. Hussain, ‘Dyeing properties of natural dyes extracted from eucalyptus’, The Journal of The Textile Institute, Vol.98, Iss.6.2007, pp.559-562.
3. S. Bains, K. Kaurand S. Kang, Colourage, 52, 5, 2005, p.51.
4. F. Benenciaand M.C. Courreges, Phytomed, 6, 2, 1999,p.119.
5. D. Bhargavaand S. Jahan, ‘Microbial Dyes; A new dimension to natural dyes’, Colourage, July 2013, pp.42-43.
6. S.K. Bhattacharya, S.M. Chatterjeeand C. Dutta,Manmade Textile in India, 58,3, 2004, p.85.

7. R. Bhuyan, C.N. Saikai and C.N. Saikai, Indian Journal of Fiber and Textile Research, 27, 12, 2002,p.429.
8. P.M. Chan, C.W.M. Yuen and K.W. Yeung, Textile Asia, 31, 2, 2000,p.28.
9. R.B. Chavanand J.N. Chakraborthy, Colour Technology, 117.
10. D. Cristea, I. Bareauand G. Vailarem, Dyes and Pigments, 2003,p.57.
11. S. Das, 'Application of natural dyes on silk', Colourage, Vol.39, Iss.9, 1992, pp.52-54.
12. R. Dayaland P.C. Dobhal, Colourage, 48,8, 2001, p.33.
13. H.T. Deoand B.K. Desai, 'Dyeing of cotton and jute with tea as a natural dye', Colouration Technology, Vol.115, Iss.7-8, July/Aug 1999, pp.224-227.
14. H.T. Deoand R. Paul, Indian Journal of Fibre and Textile Research, 25, 6, 2000, p.152.
15. S. Dixit andS. Jahan, Man-made Text in India, 48 ,7, 2005,p.252.
16. D.G. Duff, R.S. Sinclair and S. Grierson, Textile History, 16, 1, 1985,p.23.
17. C. Dwivedi and A.A. Ghazal, European Journal of Cancer Prevention, 8,5, 1997, p.449.
18. A.H. Gilaniand K.H. Janbaz, Phytotheraphy Res., 9, 5, 1995, p.449.
19. A. Guesmi et.al., 'Dyeing properties and colour fastness of wool dyed with indicaxanthin natural dye', Industrial Crops and Products, Vol. 37, Iss 1., May 2012, pp.493-499.
20. P. Guinot et.al., Colour Technology, 122, 2006, p.93.
21. M.L. Gulrajani and G. Deepti, 'Natural Dyes and their application to textiles', Department of Textile Technology, IIT, Delhi, 1992,pp.10-25.
22. M.L. Gulrajani et.al., Indian Journal of Fiber and Textile Research, 28, 2003, p.221.
23. D. Gupta, 1999, Colourage, 46, 7, 35.
24. S. Haar, E. Schrader and B.M. Gatewood, 'Comparison of aluminium mordants on the colourfastness of natural dyes on cotton', Clothing and Textiles Research Journal, Vol. 31, No. 2, April 2013, pp.97-108.
25. M.A. Haqueet.al., 'Extraction of rubiadin dye from Swieteniamahagoni and its dyeing characteristics onto silk fabric using metallic mordants', Indian Journal of Fiber& Textile Research, Vol. 38, Sep 2013, pp.280–284.
26. M. Inan,D.A. Kaya and S. Kirchi, 'The effect of dye plant amounts on colour and colour fastness of wool yarns', Industrial Textile, Vol.65, No.1, 2014, pp.29–32.
27. H. Jain, 'Dyeing of cotton fabrics with extract of jamun tree and its by-products using natural mordants', Coulourage, Nov 2013, pp.40-43.
28. M.M. Kamelet.al.,'Antibacterial activity of cationaised cotton dyed with some natural dyes', Journal of Textile Science & Engineering, Vol.5, Iss. 1, 2015, pp.1-5.
29. M.M. Kamel,M.M. El. Zawahry and F.A. ElGhafar, Journal of Textile Association, 62, 4, 2001, p.167.
30. V. Kaurand S. Sharma, 'Studies of the dyeing behaviour of natural dyes on pre mordanted regenerated bamboo yarn', Colourage, March 2015, pp.38-48.
31. M.R. Khan,A.D. Omolosoand M. Kihara, Fitoterapia, 74, 5, 2003, p.501.
32. M.A. Khan et.al.,56,1, 2006, p.61.
33. C. Zvi. Koren, Journal of Society of Dyers and Colour, 110, 9, 1994, p.273.
34. E.P.A. Kumbasar, R. Atav and M.I. Bahtiyari, 'Effects of alkali proteases on dyeing properties of various proteinous materials with natural dyes', Textile Research Journal, Vol.79, No.6, 2009,pp.517-525.
35. Y.H. Lee et.al, 'Deodorising function and antibacterial activity of fabrics dyed with gallnut extract', Textile Research Journal, Vol.85, No.10, 2015, pp.1045-1054.
36. Y. Liu and G. Bai, Bioecological mordant dyeing of silk with monascorubrin, Textile Research Journal, Vol.82, No.2, 2012, pp.203-207.
37. G. Mahale, Sakshi and R.K. Sunanda, Indian Journal of Fibre Textile Research, 28, 3, 2003, p.86.
38. J.P. Mathur and C.S. Bhandari, Indian Journal of Fiber and Textile Research, 26, 2001, p.313.
39. J.P. Mathur et.al., Indian Journal of Fiber and Textile Research, 28, 2003, p.94.
40. S. MaulikRay and S.C. radhan, Man Made Textiles in India, 48, 10, 2005, p.396.
41. B.C. Mohanty, K.V. Chandramouli and H.D. Naik, 1987, 'Studies in contemporary textile crafts of Indian-natural dyeing process of India', Calico Museum of Textiles, HN Patel Publication, Ahmedabad, 1987, pp.1-2.
42. B. Nanda et.al.,Proceedings, Conversion of Natural Dyes, 2001, p.85.
43. A.S. Nateri et.al., 'Colorimetric study on polyamides dyeing with weld and pomegranate peel natural dyes', Clothing and Textile Research Journal, Vol.32, No.2, April 2014, pp.124-135.
44. S. Neetu, and J. Shahnaz, Colourage, 50,1, 2003, p.43.
45. P. Padfieldand S. Landi, Studies in Conservation, 11, 1966, p.161.

46. N.C. Pan, S.N. Chattopadhyayand A. Day, Indian Journal of Fiber and Textile Research, 28,9, 2003, p.339.
47. K.J. Patel, B.H. Patel, J.A. Naikand A.M. Bhavar, Man-made Textiles in India, 45, 2002, p.11.
48. R. Patel and B.J. Agarwal, Proceedings, Conversion of Natural Dyes, Department of Textile Technology, 2001, p.167.
49. R. Poorniammalet.al.,'Natural dye production from Thermomycessp fungi for textile application', Indian Journal of Fiber and Textile Research, Vol. 38, September 2013, pp. 276 – 279.
50. A.V. Popoola et.al., Pakistan Journal of Scientific Industrial Research, 37,5, 1994, p.217.
51. N. Raja, Vasugi and J. Kala, Journal of Textile Association, 66, 3, 2005, p.117.
52. E. Saidman et.al., Journal of Molecular Structure, 585, (5), 2002, p.7.
53. A.K. Samanta and P. Agarwal, 'Application of natural dues on textiles', Indian Journal of Fiber and Textile Research, Vol.34, Dec 2009, pp.384-399.
54. A.K. Samanta, Agarwal, S. Dattaand A. Konar, International Dyers, 193, 4, 2008, p.25.
55. R. Sankar and P.S Vankar, 2005, Colourage, 52, 4, 35.
56. A.K. Sarkarand C.M. Seal, 'Colour Strength and colourfastness of flax fabrics dyed with natural colourants', Clothing Textile Research Journal,Vol.21, No.4, 2003, pp.162-166.
57. D. Sarkar, K. Mazumdar and S. Datta, Man-made Textiles in India, 49,1, 2006, p.19.
58. O.P. Sati, U. Rawat and B. Srivastav, Colourage, 50, 12, 2003, p.43.
59. S. Saxenaet.al., Proceedings, Convention of Natural Dyes, 2001, p.185.
60. Md. Shahidet.al.,'Dyeing fastness and antimicrobial properties of woollen yarns with gallnut (QuercusinfectoriaOliv) extract', Dyes and Pigments, Vol 95, Iss1. Oct 2012, pp. 53-61.
61. K. Singh and V. Kaur,Colourage, 53, 10, 2006, p.60.
62. R. Singh et.al.,'Antimicrobial activity of some natural dyes', Dyes and Pigments, Vol.66, Iss. 2, Aug 2005, pp.99-102.
63. S.V. Singh and M.C. Purohit, 'Evaluation of colour fastness properties of natural dye extracted from Symplocosracemosa (Lodh) on wool fibers using combination of natural and synthetic mordants', Indian Journal of Fiber and Textile Research, Vol. 39, March 2014, pp. 97-101.
64. A-Y Son, P.J. Hong, and K.T. Kim, Dyes and Pigment, 61, (3), 2007, p.63.
65. M. Srivastava, M. Pareekand Valentina, Colourage, 53, 2, 2006, p.57.
66. R. Sudhakar, K.N. Ningeand N.V. Padaki,Colourage, 53, 7, 2006, p.61.
67. M.D. Teli, R.V. Adivarker, P.P Pardeshi,'Dyeing of pretreated cotton substrate with tea extracts', Colourage, October 2002, p. 23.
68. M.D. Teli and R. Paul, International Dyers, 191, 4, 2006, p.29.
69. E.G. Tsatsaroni and I.C. Eleftheriadis, Journal of Society of Dyers and Colour, 110, 10, 1994, p.313.
70. P.S. Vankar et.al., Proceedings, "Convention of Natural Dyes", 2001,p.53.
71. P.S. Vankar, 'Chemistry of natural dyes', Resonance, Oct 2000, pp. 73-80.
72. N. Vermaand N.P. Gupta, Colourage, 42,7, 1995, p.27.
73. T. Wakidaet.al.,'Effect of low temperature plasma treatment on colour of wool and nylon 6 fabrics dyed with natural dyes', Textile Research Journal, Vol.68, No.11, Nov 1995, pp. 848-853.
74. L. Wang et.al.,'Research on dyeing and ultraviolet protection of silk fabrics using vegetable dyes extracted from flossophorae', Textile Research Journal, Vol.79, No.15, Oct 2009,pp. 1402-1409.
75. H.X. Xu and L. Song, 18,2004,p. 647.

AUTHOR BIBLIOGRAPHY

	**Dr. Afrose Fathima Farid** The author has 7 years teaching experience and was working as an Associate Professor at NIFT Kannur before taking up the current post at Justice Basheer Ahmed Sayeed College for Women, Chennai. The author is actively involved in research.