International Journal of Chemical, Materials and Biomolecular Sciences
ISSN: 2415-6620
Vol:13, No:3, 2019

Pre and Post Mordant Effect of Alum on Gamma Rays Assisted Cotton Fabric by Using *Ipomoea indica* Leaves Extract

Abdul Hafeez, Shahid Adeel, Ayesha Hussain

***Abstract*—**There are number of plants species in the universe which give the protections from different diseases and give colour for the foods and textiles. The environmental condition of the universe suggested toward the ecofriendly textiles. The aim of the paper is to analyze the influence of pre & post mordanting of alum on radiated cotton fabric with Gamma Radiation of different doses by using *Ipomoea indica* leaves extract. Alum used as mordant with the concentration of 2, 4, 6, 8 and 10% as pre and post mordanting to observe the effect of light and colour fastness of radiated cotton. 6% of alum concentration in pre mordanting gave good colour strength 117.82 with darker in shade toward the greenish tone and in post mordanting 6% concentration gave good colour strength 102.19. The lab values show that the colour is darker in tone and gave bluish effect. Further results showed that alum gave good light and rubbing fastness on gamma radiated cotton fabric.

Keywords*—Ipomoea indica*, gamma radiation, alum, light fastness.

I. Introduction

WORLD is dreary and drab without colours, colours tell the story of the object and its physical impact. To judge the any composition, colour is the only cue of the object [1].

More than two thousand years before wealth of magnificent work paying the understanding of colours. In 1672, the Sir Isaac Newton was the great artist, who published the paper on colours which was very controversial paper when he shown the white light through the prism. He observed different angles refracted wavelength of light which are the colour of rainbow [2]. People used colours to the textiles through natural dyes since ancient times. The china has the earliest record of natural dyes uses dated 2600 BC [3].

The Great Alexander mentions that he found purple roles dating to 541 BC in the Susa the royal capital when he conquered, the Persian Capital [3]. The Book Bible shows Kermes (from the kermes insect) is identified, where references are made to scarlet colored linen. Dyeing is always done to give the fabric new look and mostly for the survival from the environment. Natural dyes have significant linkage to the past and nowadays these colours are easily available in synthetic dyes [4], [14].

A. Hafeez is with the Department of Textile Design, School of Art Design & Architecture (SADA), University of Gujrat, Gujrat, Pakistan (phone: +92-334-6262978; e-mail: abdul.hafeez@uog.edu.pk).

S. Adeel is with Department of Physical Chemistry, Government Collage University Faisalabad, Pakistan (e-mail: shahidadeelchemist@gmail.com).

A. Hussain is with the Home Economics Department, Government Women University Faisalabad, Pakistan (e-mail: ayeshhussain@gmail.com)

There are number of health benefits of natural dyes as compared to the synthetic dyes. Many of natural dyes are used in medicine and in food as colour. Synthetic dyes are very dangerous for society and the environment and create pollution which causes the cancer in human and animals [13], [15]. Nowadays the demand of natural dyes is increasing due to the environmental friendly nature. That's the major reason to choose natural dyes for colorant of fabric and food [5].

The selected plant *Ipomoea indica* (Morning Glory, Blue Daura Flower) has more than 700 subspecies and it belongs to the Convolvulaceae family which belongs to the subtropical region of the world. It is found that most of its species are dangerous and also belong to the water tropical, temperate tropical and subtropical regions [1]. *Ipomoea indica* commonly invades degradable land, arable land, river banks, woodlands, and road sides. Many of them have been used as ornamentals, food and medicine or in religious ritual [5].

There are different types of radiations used for the surface medication of natural and synthetic materials. These electromagnatic rays are used in daily life for human benefits. In this research gamma radiations were used for investigation [6].

After the gamma radiation on cotton fabric, it was observed that it gave better tear and tensile stress and better pilling effect [7]. The physical properties of gamma radiated cotton were observed and found a significant change in yarn properties. Furthermore it also observed that it gave good fabric strength and good abrasion resistance [8].

The major aim of the study was the surface modification of the fabric and colour strength of the dyed RC (radiated cotton) fabric. The use of natural dyes instead of synthetic dyes is also the aim of the study.

II. Material & Procedure

Leaves of *Ipomoea indica* were collected from the surrounding of Faisalabad and washed with purified water and dried under shades. Fine powder was made through grinding the dried leaves. For obtaining the fine powder of *Ipomoea indica* leaves, they are passed through the fine sieve and powder was stored at room temperature in glass jar for further experimentation [9].

Bleached cotton fabric with plain weave were selected from the market and further processed with the soap before dying [10]. Gamma radiation with ranging 5-20 kGy was used on cotton fabric by using Cs 137 Gamma Irradiator.

National Textile University, Faisalabad provide the facility

to check the physical properties of gray and radiated cloth. The spectra flash spectrometer was used to check the parameter of died fabric [11], [17]. Aqua, methanol, and alkali (NaOH) were used as extraction media to check the better colour strength of *Ipomoea indica* leaves powder [12]. In 500 ml beaker non radiated powder was stirred on hot plate for 45 minutes with material to liquor ratio: 1:30. Further, cotton cloth is used to filtered the extract and stored in glass jar for further dying experiments.

TABLE I
SALT CONCENTRATION

Experiment	Concentration of Salt/100 ml
1.1	2 g
1.2	4 g
1.3	6 g
1.4	8 g
1.5	10 g

Ipomoea Indica leaves extract were used to measure the optimum condition of salt concentration, material to liquor ratio, temperature and time. The salt concentration is used with the range of 2-10 g/100 ml with material to liquor ratio ranging from 1:20, 1:30, 1:40, 1:50, 1:60 [16], the dyeing time ranging from 20, 30, 40, 50, 60 minutes and temperature from the range of 30, 40, 50, 60 and 70 °C.

Alum was used as a mordanting agent with range 2-10 g as shown in Table II in pre and post-mordanting to check the best colour strength.

TABLE II
PRE & POST MORDANTING CONCENTRATION

Mordant	Experiment	Concentration of Mordant for pre & post mordanting				
Alum(pre)	2.1-2.5	2%	4%	6%	8%	10%
Alum(post	2.1-2.5	2%	4%	6%	8%	10%

Distinctive parameters were used to check the washing, light and rubbing fastness properties of gamma radiated dyed fabric with *Ipomoea indica* leaves extract. After dying fabric with the optimum conditions, the colour fastness and strength were calculated at Noor Fatima Textile pvt. Limited Faisalabad, Pakistan [17].

III. RESULT & DISCUSSIONS

Water was used as an extraction media with ML ratio: 1:30 for the *Ipomoea indica* leaves powder to dye the cotton fabric. It was observed that 20 kGy is the optimal dosage for surface modification of cotton fabric.

TABLE III
WATER EXTRACTION ON GAMMA RADIATED DYED FABRIC

Sample Code	Extraction Media	Absorbed Doses kGy	DL*	Da*	Db*	Color strength %
(NRP/RC)	Water	5	7.48	-0.46	0.49	**53.4**
(NRP/RC)	Water	10	6.48	-0.44	-0.62	**58.6**
(NRP/RC)	Water	15	8.64	-0.85	-0.75	**47.97**
(NRP/RC)	Water	20	-1.44	0.07	-0.37	**111.79**

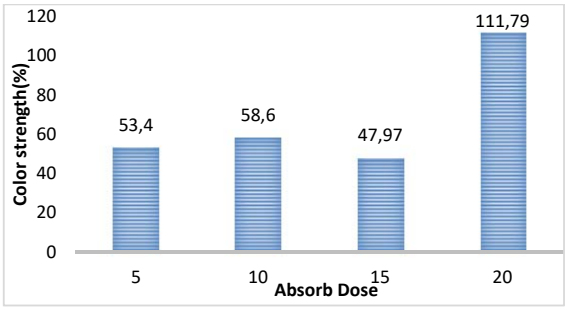

Fig. 1 Water Extraction on Gamma Radiated Dyed Fabric

TABLE IV
EFFECT OF GAMMA RADIATION ON FABRIC DENSITY, WEIGHT AND PILLING

Fabric Code	Sample	Fabric Density		Pilling	Fabric Weight
		PPI(weft)	EPI(warp)		
C0	Cotton	92	124	5	0.85
C5	Cotton	91	123	5	0.84
C10	Cotton	91	124	1-2	0.82
C15	Cotton	92	124	5	0.85
C20	Cotton	191	124	2-3	0.84

TABLE V
EFFECT OF GAMMA RADIATION ON TEAR STRENGTH OF COTTON FABRIC BEFORE DYE

Dosage on Cotton Fabric	P(warp)	T(weft)
C0	280	120
	280	140
	280	160
C5	200	40
	240	40
	240	60
C10	240	140
	240	120
	260	120
C15	240	40
	240	40
	240	40
C20	240	40
	200	30
	220	20

TABLE VI
EFFECT OF GAMMA RADIATION ON TENSILE STRENGTH OF COTTON FABRIC BEFORE DYE

Dosage on Cotton Fabric	P(warp)	T(weft)
C0	32	20
	35	21
	34	20
C5	33	19
	27	21
	25	20
C10	35	21
	32	16
	38	22
C15	30	22
	32	20
	32	21
C20	29	20
	25	18
	30	20

In aqua media the study shows that the colour strength of 5 kGy gamma radiated cotton fabric is 53.4 and increases as we increase the dose of 10 kGy and suddenly decreases at 15 kGy gamma radiated cotton fabric. The best colour strength was observed at 20 kGy dose on cotton dyed fabric.

Gamma radiated cotton fabric was dyed with *Ipomoea indica* leaves extract with different salt concentrations ranging from 2 g to 10 g per 100 ml to check the best concentration.

TABLE VII
SALT CONCENTRATION IMPACT ON DYE OF COTTON FABRIC

Experiments	DL*	Da*	Db*	Salt Concentration (g/100 ml)	Relative Color Strength %
8.1	-5.16	-0.08	1.52	2	164.28
8.2	-6.83	0.09	2.00	4	188.3
8.3	-4.66	-0.04	3.16	6	181.96
8.4	0.82	-0.38	1.78	8	113.6
8.5	-5.74	-0.64	2.63	10	195.86

Fig. 2 shows that as salt concentration rises to 4 g then the color strength declines as salt concentration increases from 4 g to 8 g then the color strength increases rapidly at concentration 10 g of salt.

One gram of gamma-radiated cotton fabric was used to measure the best material liquor ratio (ML Ratio), which shown in Table VIII with the sample code ML 20, ML 30, ML 40, ML 50 and ML 60.

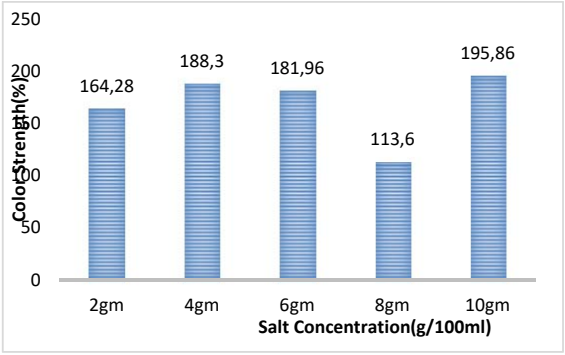

Fig. 2 Salt Concentration impact on dye of cotton fabric

Table VIII shows that the best material liquor ratio was 1:20 which gave the best relative colour strength 140.91 and the CIELAB values Da*, DL* and Db* show that the colour of gamma-radiated dyed fabric was blush green in tone and gave darker shade.

TABLE VIII
MATERIAL TO LIQUOR RATIO IMPACT ON DYED COTTON FABRIC

Experiment	Sample Code	Condition	Da×	DL×	Db×	Relative Color Strength %
9.1	ML 20	(1:20)	-0.01	-5.08	-0.16	140.91
9.2	ML 30	(1:30)	0.22	-1.25	2.75	130.66
9.3	ML 40	(1:40)	0.19	-3.31	0.82	130.17
9.4	ML 50	(1:50)	-0.68	-1.39	0.77	121.08
9.5	ML 60	(1:60)	-0.07	-0.46	-0.25	115.89

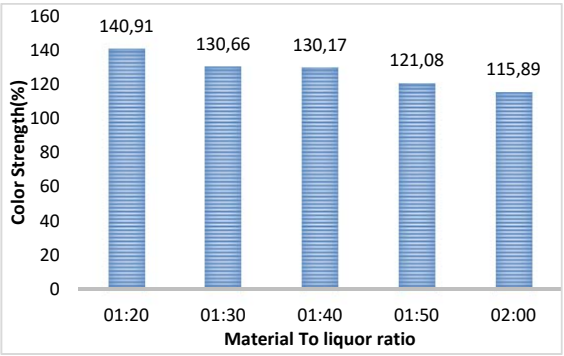

Fig. 3 Effect of Material to liquor Ratio on dye of cotton fabric

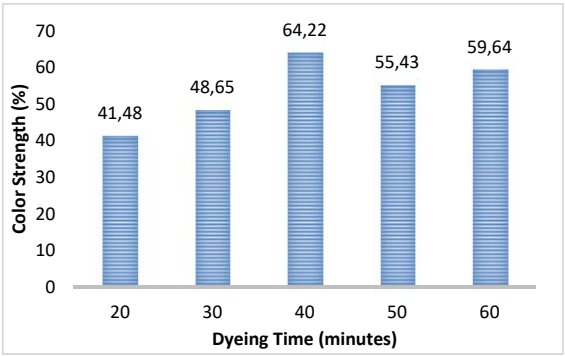

Fig. 4 Effect of dying time

TABLE IX
EFFECT OF DYING TIME

Sample Code	Condition	Relative Color Strength %
T 20	20	41.48
T 30	30	48.65
T 40	40	64.22
T 50	50	55.43
T 60	60	59.64

Table IX shows the effect of dyeing time on gamma radiated cotton fabric with *Ipomoea indica* leaves extract and the best dyeing time was 40 minutes which gave the best colour strength of 62.22% as shown in Fig. 4.

All the optimized conditions gave the optimum values for pre and post mordanting effect of alum on gamma radiated cotton fabric. Pre mordanting is done by changing the concentration of the mordant agent from 2-10% as shown in Table X.

TABLE X
PRE-MORDANTING EFFECT OF ALUM ON GAMMA RADIATED COTTON FABRIC

Concentration	Alum			
	Color strength %	DL*	Da*	Db*
2%	114.65	0.72	-1.26	1.20
4%	105.97	1.32	-1.40	0.72
6%	117.82	-0.09	-0.77	1.44
8%	104.68	0.51	-0.91	0.54
10%	107.37	0.65	-0.93	0.95

In Table X in pre mordanting the best value is 6% alum concentration as mordanting agent gave better color strength. At this value alum gave 117.82 colour strength and DL× value -0.09 shows that colour is darker in shades and Da× value -0.77 shows that colour is in greenish tone and Db× value 1.44 shows that it goes toward the yellowish side.

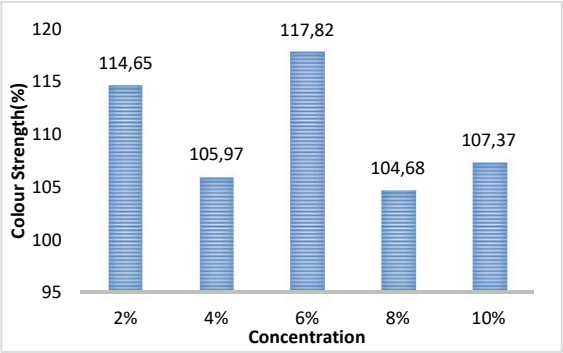

Fig. 5 Pre mordanting effect of alum concentration

Fig. 5 shows the graphical representation of colour value of the alum as a pre mordanting agent. To investigate the best post mordanting effect of Alum on gamma radiated cotton fabric, different concentrations of alum were used from 2%, 4%, 6%, 8%, and 10% as shown in Table XI.

TABLE XI
POST MORDANTING EFFECT OF ALUM ON GAMMA RADIATED COTTON FABRIC

Concentration	Alum			
	Color strength %	DL*	Da*	Db*
2%	100.56	-0.92	-0.92	-1.29
4%	73.9	2.05	-0.35	-2.20
6%	102.19	-1.39	-0.55	-1.41
8%	97.58	0.36	-0.98	-1.46
10%	71.93	2.94	-1.27	-1.80

Table XI of post mordanting effect shows that 6% of alum concentration gave good colour strength; the negative value DL× (-1.39) indicates the darker shades of the colour; and Da× (-0.55) and Db× values show that the colour was toward greenish blue in Color Space Notation. Graphical representation is shown in Fig. 6.

To check the fastness toward the light ISO 105 B02-1994 was used and AATCC crock meter was used for rubbing fastness and specimen assessed with the grey scale for staining. The dye structure is very important to change the dye reaction toward the fiber. Upon exposure to light, detergent and rubbing the resistance and colour fastness rating improved. Thus gamma ray treatment of fabric gave better rating with un-irradiated *Ipomoea indica* leaves extract.

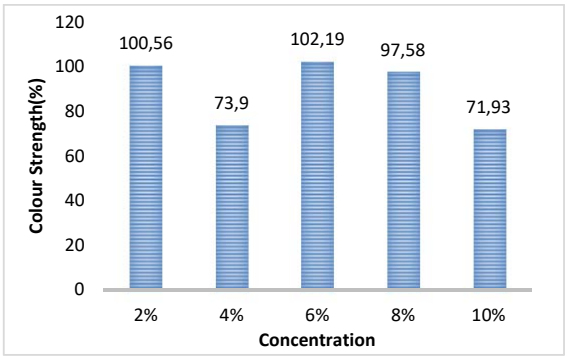

Fig. 6 Post mordanting effect of Alum on gamma radiated cotton fabric

TABLE XII
LIGHT FASTNESS EFFECT OF DYED FABRIC

Mordant	Pre-Mordanting	Post-Mordanting
Alum	3	3/4

Alum gave average light fastness as pre-mordanting agent and good on post-mordanting according to the rationg of gray scale.

TABLE XIII
EFFECT OF WASHING FASTNESS ON DYED FABRIC

Name of Sample	Shade Change	Staining
Al (pre-mordanting)	4	4/5
Al (post-mordanting)	4	4/5

TABLE XIV
EFFECT OF RUBBING FASTNESS ON DYED FABRIC

Name of Sample	Dry	Wet
Al (pre-mordanting)	4/5	4
Al (post-mordanting)	4/5	4

Table XIV shows that dyed sample with *Ipomoea indica* leaves extract gave similar behavior toward the rubbing fastness which shows that pre and post mordanting dyes equally penetrate on gamma radiated cotton fabric.

IV. CONCLUSIONS

This study reported the fastness effect of Alum as pre and post mordanting agent on gamma radiated cotton fabric with *Ipomoea indica* leaves extract. The result showed that at the optimum conditions the alum gave good colour strength 117.82 and 102.19 of alum with 6% concentration on pre and post mordating respectively. The mordanting was performed after the optimization conditions i.e. salt concentration 2 g/100 ml and material to liquor ratio 1:30 on dying time 40 min with 60 ℃ temperature. The light fastness gave value 3 in shade change and 3-4 in staining which is good fastness property. Same result was also calculated in washing and rubbing fastness. The values 4 and 4-5 show excellent washing and

rubbing fastness of pre and post mordanting of Alum on gamma radiated cotton fabric with *Ipomoea indica* leaves extract.

ACKNOWLEDGMENT

This research was accomplished at Government College University, Faisalabad (GCUF) with the assistance of Mr. Shahid Adeel and Ms. Ayesha Hussain at the Department of Home Economics. The author thanks the Testing Department of Noor Fatima Textiles (Pvt.) Ltd Faisalabad for providing the facilities of fabric experimentation. The author also appreciates the Colleagues from National Textile University who played a vital rule to support the research.

REFERENCES

[1] Watkins, M. (2005). Seeing red, the metaphysics of colours without the physics. *Australasian Journal of Philosophy*, *83*(1), 33-52.
[2] Schaffer, S. (1989). Glass works: Newton's prisms and the uses of experiment. *The uses of experiment: Studies in the natural sciences*, 67-104.
[3] Siva, R. (2007). Status of natural dyes and dye-yielding plants in India. *Current science*, 916-925.
[4] Mariod, A., & Matthäus, B. (2008). Physico-chemical properties, fatty acid and tocopherol composition of oils from some Sudanese oil bearing sources. *Grasas y aceites*, *59*(4), 321-326.
[5] Abodunrin, T. J., Obafemi, O., Boyo, A. O., Adebayo, T. A., & Jimoh, R. (2015). The effect of electrolyte on dye sensitized solar cells using natural dye from mango (M. indica L.) Leaf as Sensitizer. *Advances in Materials Physics and Chemistry*, *5*.
[6] Proctor, B. E., & Goldblith, S. A. (1951). Electromagnetic radiation fundamentals and their applications in food technology. In *Advances in Food Research* (Vol. 3, pp. 119-196). Academic Press.
[7] Batool, F., Adeel, S., Azeem, M., Khan, A. A., Bhatti, I. A., Ghaffar, A., & Iqbal, N. (2013). Gamma radiations induced improvement in dyeing properties and colorfastness of cotton fabrics dyed with chicken gizzard leaves extracts. *Radiation Physics and Chemistry*, *89*, 33-37.
[8] Miao, M., Hawkins, S. C., Cai, J. Y., Gengenbach, T. R., Knott, R., & Huynh, C. P. (2011). Effect of gamma-irradiation on the mechanical properties of carbon nanotube yarns. *Carbon*, *49*(14), 4940-4947.
[9] Bhattacharyya, K. G., & Sharma, A. (2004). Adsorption of Pb (II) from aqueous solution by Azadirachta indica (Neem) leaf powder. *Journal of hazardous materials*, *113*(1-3), 97-109.
[10] Tzanov, T., Calafell, M., Guebitz, G. M., & Cavaco-Paulo, A. (2001). Bio-preparation of cotton fabrics. *Enzyme and Microbial Technology*, *29*(6-7), 357-362.
[11] Dimitrovski, K., & Gabrijelcic, H. (2004). Corrections of color values of woven fabrics using changes to constructional parameters. *AUTEX research journal*, *4*(4), 187-193.
[12] Wisniak, J. A. I. M. E. (2004). Dyes from antiquity to synthesis. *Indian Journal of History of Science*, *39*(1), 75-100.
[13] He, J., & Giusti, M. M. (2010). Anthocyanins: natural colorants with health-promoting properties. *Annual review of food science and technology*, *1*, 163-187.
[14] Satyanarayana, S. V., Sharma, A., & Bhattacharya, P. K. (2004). Composite membranes for hydrophobic pervaporation: study with the toluene–water system. *Chemical Engineering Journal*, *102*(2), 171-184.
[15] He, J., & Giusti, M. M. (2010). Anthocyanins: natural colorants with health-promoting properties. *Annual review of food science and technology*, *1*, 163-187.
[16] Ali, S., Hussain, T., & Nawaz, R. (2009). Optimization of alkaline extraction of natural dye from Henna leaves and it's dyeing on cotton by exhaust method. *Journal of cleaner production*, *17*(1), 61-66.
[17] Adeel, S., Usman, M., Haider, W., Saeed, M., Muneer, M., & Ali, M. (2015). Dyeing of gamma irradiated cotton using Direct Yellow 12 and Direct Yellow 27: improvement in colour strength and fastness properties. *Cellulose*, *22*(3), 2095-2105.