

**EFFECT OF CATIONIZATION ON THE SHADE DEPTH
AND DYE FIXATION OF 100% COTTON KNITTED
FABRIC: A STUDY FOR EXTENSION OF TEXTILE
TECHNOLOGY**

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ABSTRACT

The present research work entitled “Effect of cationization on the shade depth and dye fixation of 100% cotton knitted fabric” was conducted to study the controlling parameters on the dyeing and cationization of cotton knitted fabric and thus to choose the conditions under which these cationic agents were applied. Dyeing properties (dye fixation and shade depth) of the fabric samples under different variables were examined. Shade depth and dye fixation results were also good for all fabric types treated with different cationic agents. The purpose of the study is to explore the textile research via extension methods to the textile industries.

INTRODUCTION

The primary objective of pretreatment with the reactive quaternary agent is to increase the exhaustion of anionic dyes. For optimum results the quaternary

agents react efficiently with the fibre in order to avoid dye restraining as a result of adsorption. The reactive dye showed better wet fastness properties. If salt or alkali is not used during the dyeing process then the yield and fastness properties are not optimum. Sometimes an objectionable odour can also occur in the fabric after cationization [6]. Dyes are intensely coloured substances used for the colouration of various substrates, including paper, leather, fur, hairs, foods, drugs, cosmetics, and textile materials. To select a proper dye for a fibre, it is necessary to know which dyes have an affinity for the fibre and the buyer. Now a day, the main objective of the dyed fabrics to withstand the deteriorating elements or influences to which the finished cloth will be subjected-sunlight, perspiration, washing, pressing, and friction [1]. The cationized cotton showed enhanced antibacterial properties, the potency increasing with increasing hydrocarbon chain length. With the cationization of cotton the hue on the cationized cotton becomes darker and most of the dyeing take place at the surface of the fabric because of the surface positive charge [6]. Eight commercially available formaldehyde-based and non-formaldehyde fixing agents, both for physico-chemical properties and performance on cotton fabric dyed with C.I. Reactive Blue 41 and C.I. Reactive Red 11. The non-formaldehyde type fixing agents gave a better overall performance in terms of less dye bleaching and shade alteration (tone change), combined with excellent fastness to water and light [5]. Pre-treatment of cotton fabrics with mono and bis-reactive cationic agents produces a fibre that might be dyed with direct dyes under neutral condition in the absence of salt. Fairly high degree of exhaustion and fixation and improved wet fastness were achieved for all cases of cationized cotton fabrics compared to untreated samples. The results also indicate that cotton pre-treated with the bisreactive cationic agents showed higher degrees of dye exhaustion and fixation relative to cotton pretreated with the mono-reactive agents [8]. The dye fixation was found to be much higher than by conventional dyeing without pretreatment, even in the presence of a large amount of salt. The

influence of pretreatment conditions on dye fixation, such as pad-bake variables and the concentration of poly (vinyl amine chloride) had studied [7].

MATERIALS AND METHODS

The research work entitled “Influence of pre and post cationization upon dye shades w. r. t. washing and light fastness” was initiated in the Department of Fibre Technology, University of Agriculture Faisalabad and was conducted in Masood Textile Mills Ltd. Faisalabad, Pakistan, during the year 2010.

Grey knitted cotton fabric was collected from mills warehouse in order to evaluate the effectiveness of different variables on their dyeing behavior and cationization applications. Following variables were selected to study their effects.

Cationic Agents (A)	Shade %age	Temperature (°C)	Time (Min) (t)
A ₁ = Sandofix RSL	S ₁ =Light	T ₁ =20	t ₁ =15
A ₂ = Solidogen RDL	S ₂ =Medium	T ₂ =40	t ₂ =20
A ₃ = Indosol E-50	S ₃ =Dark	T ₃ =60	t ₃ =25
A ₄ = Metacil FC-ER			t ₄ =30
A ₅ = Albafix FRD			
A ₆ = Albafix WFF			

The study was completed in following steps.

- Grey cloth treatment
- Dyeing of knitted cotton fabric

- Cationic Agents application
- Standard colour fastness test

3.1 Pretreatments of cotton

Pretreatments play an important role in subsequent processing of textiles.

3.1.1 Singeing

In singeing unwanted surface hairs or filaments are removed from fabric either by burning against a hot plate or on a flame. The operation is usually performed before desizing. The greige cloth is passed through first blower to clean the cloth from fluff and then the cloth enter into the burner chamber where the protruding fibre ends on both sides are burnt by hot flame coming at an angle of 90°.

After this the cloth enters into another blow chamber where ash on surface is removed so that it becomes favorable for desizing. The care should be taken that temperature of the flame does not fall below the ignition point of the cotton fibre and flame does not bend over in order to avoid the scouching of fabric.

3.1.2 Desizing

The size applied creates a hydrophobic layer inhibiting dye absorption and promoting a stiff handle in the woven fabric. The desizing process removes the size to a large extent. However, cellulosic fibres and cellulosic fibre blends are often treated with starch based size that is only partially soluble in water. The starch has to be chemically broken down into smaller water-soluble fragments. The key steps in the process are to impregnate with desizing agent for a definite time interval, wash off the soluble sugars formed.

After batching, material was rinsed in hot water (90⁰C) to remove decomposed starch, fats, waxes and pigment impurities. It was then given cold rinsing treatment.

3.1.3 Scouring

Cotton fabric samples are usually scoured with hot alkali. Scouring is the process by which fats waxes, pectins and other hydrophobic matters are removed from the fabric to increase its wetability. After disizing, the cotton still contains certain substances which make it hydrophobic, these are mainly waxes, pectins, ash and organic impurities. Such impurities have to be removed with the aid of scouring. In this treatment exhaust method was used. The procedure are given below.

Procedure

Samples of cotton fabric were put into the scouring bath at about 55⁰C and then the temperature of bath was raised up to 90⁰C and maintained the temperature for half an hour. The bath was then allowed to cool at low temperature. The samples were taken out, rinsed in hot and cold water respectively. Finally the samples were hydro extracted and dried.

3.1.4 Bleaching

Bleaching is a process in which the grey cloth is treated with some oxidizing agent (called bleaching agent) after thorough wetting of the textile material to remove natural grey colour, some undesirable impurities and pigments etc. and as a result the textile material become white and soft. In other words, bleaching is a method of improving whiteness of the textile material by decolorizing it from the grey state. After scouring, the fabric still has a yellowish tinge which makes it unsuitable for dyeing, so that at this point bleaching is necessary for fabric. The procedure is given below.

Procedure

The scoured dry samples were put into the bleaching bath at about 40⁰C and then raised the temperature of the bath up to 90⁰C, maintaining this temperature for about one hour, the bath was allowed to cool and at low temperature the sample was taken out, rinsed first in hot and then in cold water. Finally the sample was hydro extracted and dried.

3.2 Dyeing of knitted cotton fabric**3.2.1 Dyeing of cotton fabric samples *with* Direct Dyes**

Samples of pure cotton knitted fabric after desizing and bleaching were dyed by exhaust dyeing method with red colour of dyestuff (commercial direct dye Indosol Red BA. The recipe and procedure is given as under:

Preparation of stock solution

The amount of .5g, 2.5g and 4g of the dye was added with boiling water. After well shaking, it was diluted to 100ml to get the required shade percentage of the dye solution.

Procedure

The specimens were dyed by the method of direct dyeing. The liquor ratio was set 1:33 according to the desire level of dyeing Shades. Firstly the dye solution was added in the dyebath to get the light shade. Wet cotton fabric was soaked in the dyebath. The dyebath stuff was sterilized up to 5 minute and temperature was raised up to 100C. The dye was suddenly penetrated onto the fabric samples. The amount of 2% NaCl was added to dyebath to enhance the dye rate. The temperature then enhanced to 800C. Total dyeing time was 45 minutes. The samples were washed, rinsed, cold and dried. Now the same process was used to get the medium and dark shades. The different apparatus was set to take the readings of colour fastness tests and fabric properties [4].

3.3 Cationic Agents Application.

The cationic agent's applications were applied to the different fabrics to increase shade percentage and reduce needle cutting when the garment is sewn.

Preparation of Stock Solution

The amount of 10 g/l for 1 % concentration of the cationic agent was added with boiling water. Then acetic acid for pH was added.

Procedure

The bleached cotton knitted fabric specimens were dipped in three beakers for light, medium and dark shades. Then 0.2g weight of the cationic agent in each beaker was taken for making solutions for required shades. Then placed them into the heater and performed the process at the required temperatures (20°C, 40°C and 60°C) and times (15min, 20min, 25min and 30min). The fabric pieces for light, medium and dark shades were dipped into the solutions stir them with a rod for the required process time to control the unevenness of the dye shade. After the required time, cold washing the fabric pieces and squeezed them and put them in a dryer for 8-10 minutes for drying. Now repeat the process with dyed cotton knitted fabric specimens. The same process was performed for Sandofix RSL, Solidogen RDL, Indosol E-50, Metacil FC-ER, Albafix FRD and Albafix WFF cationic agents. After this process, the required tests were experimented to discuss the readings.

3.4 Testing of Dyed Samples

After dyeing the samples were washed out thoroughly and finally dried. The dyed samples were then subjected to the following tests.

3.4.1 Shade Depth

Shade depth is the most important property of the dyed fabric samples which evaluates that how much darker or lighter are the batched sample as

compared to the standard sample. For shade depth, Data Colour SF 600 was used for conventional dyeing techniques. In the DataColour SF 600, conventional dyed sample was considered as a standard sample and on the basis of standard sample; the darkness or lightness of dyed sample was evaluated on the basis of lightness, chrome and hue, shade depth parameters.

3.4.2 Dye Fixation

Dye fixation was an important property which measured how much dye was fixed onto the fabric after dyeing. For dye fixation, UV/VIS Spectrophotometer was used for conventional dyeing techniques. In the UV/VIS Spectrophotometer, dye fixation was measured on the basis of spectral data on a specific wavelength. The wavelength used for dye fixation onto the fabric was 570 nm.

In the Spectrophotometer, the dyed samples of both conventional dyeing techniques were fixed in the dark hole with lens at a fixed wavelength 570 nm and after 30 seconds, UV/VIS Spectrophotometer showed the dye fixation value of the fabric on the display.

3.5 Statistical analysis of data

The data thus obtained will be analyzed statistically [2] using M-Stat Micro-Computer Statistical Programmed [3].

RESULT AND DISCUSSION

The present research work entitled “Impact of pre and post cationization upon dye shades” was conducted to study the controlling parameters on the dyeing and cationization of cotton knitted fabric and thus to choose the conditions under which these cationic agents were applied.

Dyeing properties (dye fixation and shade depth) of the fabric samples under different variables were examined.

Shade depth (pre-dyeing)

The comparisons of individual treatments mean values of shade depth pre dyeing for different cationic agents (A) showed non-significant results. The highest mean value of shade depth pre dyeing for dye categories (A) is 108.19 for A₆ (Albafix WFF) followed by 108.18, 108.17, 108.16, 108.16 and 108.16 for A₃ (Indosol E-50), A₅ (Albafix FRD), A₂ (Solidogen RDL), A₄ (Metacil FC-ER) and A₁ (Sandofix RSL) respectively.

The comparison of individual treatments mean values of shade depth pre dyeing for different shade percentages (S) showed significant results. The highest mean value of shade depth pre dyeing for shade percentages (S) is 109.21 for S₃ (Dark) followed by 108.87 and 108.38 for S₂ (Medium) and S₁ (Light) respectively.

The comparison of individual treatments mean values of fabric shade depth pre dyeing for different temperatures (T) showed non-significant results. The highest mean value of fabric shade depth pre dyeing for different temperatures (T) is 108.43 for T₃ (60) followed by 108.41 and 108.41 for T₂ (40) and T₁ (20) respectively.

The comparison of individual treatments mean values of fabric shade depth pre dyeing for different time settings (t) showed significant results. The highest mean value of fabric shade depth pre dyeing for different time settings (t) is 123.41 for t₄ (30) followed by 113.38, 104.36 and 92.33 for t₂ (25), t₃ (20) and t₄ (15) respectively.

Table 1 : Analysis of Variance for Shade Depth (Pre-treatment)

Source	DF	SS	MS	F	P
A	5	2.55407	0.51	0.65	N.S
S	2	22.00603	11.00	13.93	0.0306*
T	2	1.37010	0.69	0.87	N.S

T	3	18.4600	6.15	7.79	0.0050*
A*S	10	9.00107	0.90	1.14	N.S
A*T	10	10.02432	1.00	1.27	N.S
A*t	15	12.03988	0.80	1.02	N.S
S*T	4	3.38135	0.85	1.07	N.S
S*t	6	3.66704	0.78	0.98	N.S
T*t	6	4.12731	0.69	0.87	N.S
A*S*T	20	16.77336	0.84	1.06	N.S
A*S*t	30	28.00243	0.93	1.18	N.S
A*T*t	30	28.08033	0.94	1.18	N.S
S*T*t	12	11.07236	0.92	1.17	N.S
A*S*T*t	60	54.60	0.91	1.16	N.S
Error	60	1.48835	0.77		
Total	275	227.648			

*Significant, N.S : Non-Significant

Table 1a: Comparison of Individual Treatments Means of Shade Depth (Pre-treatment)

A	Mean	S	Mean	T	Mean	T	Mean
A1	108.16C	S1	108.38C	T1	108.41A	t1	92.33D
A2	108.16C	S2	108.87B	T2	108.41A	t2	104.36C
A3	108.18B	S3	109.21A	T3	108.43A	t3	113.38B
A4	108.16c					t4	123.41A
A5	108.17AB						
A6	108.19A						

Mean Value having different letters, differ significantly at 0.05 level of probability

Shade depth (post-dyeing)

The comparisons of individual treatments mean values of shade depth post dyeing for different cationic agents (A) showed non-significant results. The highest mean value of shade depth post dyeing for dye categories (A) is 108.3 for A₅ (Albafix FRD) followed by 108.2, 108.1, 108.1, 108.1 and 108.1 for A₃ (Indosol E-50), A₄ (Metacil FC-ER), A₆ (Albafix WFF), A₂ (Solidogen RDL) and A₁ (Sandofix RSL) respectively.

The comparison of individual treatments mean values of shade depth post dyeing for different shade percentages (S) showed significant results. The highest mean value of shade depth post dyeing for shade percentages (S) is 109.2 for S₃ (Dark) followed by 108.7 and 108.2 for S₂ (Medium) and S₁ (Light) respectively.

The comparison of individual treatments mean values of fabric shade depth pre dyeing for different temperatures (T) showed non-significant results. The highest mean value of fabric shade depth pre dyeing for different temperatures (T) is 108.78 for T₃ (60) followed by 108.77 and 108.77 for T₂ (40) and T₁ (20) respectively.

The comparison of individual treatments mean values of fabric shade depth post dyeing for different time settings (t) showed significant results. The highest mean value of fabric shade depth post dyeing for different time settings (t) is 128.33 for t₄ (30) followed by 118.16, 108.83 and 98.16 for t₂ (25), t₃ (20) and t₄ (15) respectively.

Table 1.2 : Analysis of Variance for Shade Depth (Post-treatment)

Source	DF	SS	MS	F	P
A	5	5.55407	1.11	1.41	N.S
S	2	41.00603	20.12	25.79	0.0303*
T	2	1.37001	0.69	0.87	N.S
T	3	18.4600	6.15	7.79	0.0401*
A*S	10	9.00107	0.90	1.14	N.S
A*T	10	9.02421	0.90	1.14	N.S
A*t	15	14.03988	0.94	1.18	N.S
S*T	4	3.38112	0.85	1.07	N.S
S*t	6	5.66715	0.94	1.20	N.S
T*t	6	4.12712	0.69	1.12	N.S
A*S*T	20	17.77336	0.89	1.22	N.S
A*S*t	30	29.00243	0.97	1.18	N.S
A*T*t	30	28.08033	0.94	1.17	N.S
S*T*t	12	11.07206	0.92	1.17	N.S
A*S*T*t	60	55.800	0.93		N.S
Error	60	1.48835	0.79		
Total	275	254.8402			

*Significant, N.S : Non-Significant

**Table 1.2a : Comparison of Individual Treatments Means of Shade Depth
(Post-treatment)**

A	Mean	S	Mean	T	Mean	T	Mean
A1	108.1C	S1	108.2C	T1	108.77A	t1	98.16D
A2	108.1C	S2	108.7B	T2	108.77A	t2	108.83C
A3	108.2B	S3	109.2A	T3	108.78A	t3	118.16B
A4	108.1c					t4	128.33A
A5	108.3A						
A6	108.1C						

Mean Value having different letters, differ significantly at 0.05 level of probability

Dye Fixation (pre-dyeing)

The comparisons of individual treatments mean values of dye fixation pre dyeing for different cationic agents (A) showed non-significant results. The highest mean value of dye fixation pre dyeing for dye categories (A) is 1.00 for A₃ (Indosol E-50) followed by 0.98, 0.94, 0.91, 0.89 and 0.88 for A₆ (Albafix WFF), A₁ (Sandofix RSL), A₅ (Albafix FRD), A₂ (Solidogen RDL), A₄ (Metacil FC-ER) and respectively.

The comparison of individual treatments mean values of dye fixation pre dyeing for different shade percentages (S) showed significant results. The highest mean value of dye fixation pre dyeing for shade percentages (S) is 0.98 for S₃ (Dark) followed by 0.94 and 0.89 for S₁ (Light) and S₂ (Medium) respectively.

The comparison of individual treatments mean values of dye fixation pre dyeing for different temperatures (T) showed non-significant results. The highest

mean value of fabric dye fixation pre dyeing for different temperatures (T) is 0.98 for T₃ (60) followed by 0.95 and 0.90 for T₁ (20) and T₂ (40) respectively.

The comparison of individual treatments mean values of fabric dye fixation pre dyeing for different time settings (t) showed significant results. The highest mean value of fabric dye fixation pre dyeing for different time settings (t) is 1.08 for t₄ (30) followed by 1.04, 0.98 and 0.94 for t₃ (25), t₂ (20) and t₁ (15) respectively.

Table 2 : Analysis of Variance for Dye Fixation (Pre-treatment)

Source	DF	SS	MS	F	P
A	5	4.87124	0.97	1.23	N.S
S	2	132.402	66.20	83.80	0.0041**
T	2	1.71027	0,86	1.08	N.S
T	3	240.541	80.18	101.49	O.0009**
A*S	10	9.65145	0.97	1.22	N.S
A*T	10	9.79529	0.98	1.24	N.S
A*t	15	12.67414	0.84	1.07	N.S
S*T	4	3.14011	0.79	0.99	N.S
S*t	6	7.28424	1.21	1.54	N.S
T*t	6	5.25627	0.88	1.11	N.S
A*S*T	20	18.60330	0.93	1.18	N.S
A*S*t	30	27.54001	0.92	1.16	N.S
A*T*t	30	21.46929	0.72	0.91	N.S
S*T*t	12	11.98231	1.00	1.26	N.S
A*S*T*t	60	57.60	0.96	1.41	N.S
Error	60	4.82330	0.68		
Total	275	574.121			

** Highly Significant, N.S : Non-Significant

Table 2a : Comparison of Individual Treatments Means of Dye Fixation (Pre-treatment)

A	Mean	S	Mean	T	Mean	T	Mean
A1	0.94C	S1	0.94B	T1	0.95B	t1	0.94C
A2	0.89BC	S2	0.89C	T2	0.90C	t2	0.98B
A3	1.00A	S3	0.98A	T3	0.98A	t3	1.04A
A4	0.88BC					t4	1.08A
A5	0.91C						
A6	0.98B						

Mean Value having different letters, differ significantly at 0.05 level of probability

Dye Fixation (post-dyeing)

The comparisons of individual treatments mean values of dye fixation post dyeing for different cationic agents (A) showed non-significant results. The highest mean value of dye fixation post dyeing for dye categories (A) is 1.38 for A₆ (Albafix WFF) followed by 1.37, 1.31, 1.30, 1.25 and 0.98 for A₅ (Albafix FRD), A₁ (Sandofix RSL), A₃ (Indosol E-50), A₂ (Solidogen RDL) and A₄ (Metacil FC-ER) respectively.

The comparison of individual treatments mean values of dye fixation post dyeing for different shade percentages (S) showed significant results. The highest mean value of dye fixation post dyeing for shade percentages (S) is 1.61 for S₁ (Light) followed by 1.52 and 1.46 for S₂ (Medium) and S₁ (Light) respectively.

The comparison of individual treatments mean values of dye fixation post dyeing for different temperatures (T) showed non-significant results. The highest mean value of fabric dye fixation post dyeing for different temperatures (T) is 1.31 for T₁ (20) followed by 1.30 and 1.29 for T₂ (40) and T₁ (20) respectively.

The comparison of individual treatments mean values of fabric dye fixation post dyeing for different time settings (t) showed significant results. The highest mean value of fabric dye fixation post dyeing for different time settings (t) is 1.31 for t_4 (30) followed by 1.31, 1.29 and 1.29 for t_3 (25), t_2 (20) and t_1 (15) respectively.

Table 2 : Analysis of Variance for Dye Fixation (Post-treatment)

Source	DF	SS	MS	F	P
A	5	4.32187	0.86	1.29	N.S
S	2	39.41202	19.71	29.46	0.0515*
T	2	1.71027	0.86	1.28	N.S
T	3	243.512	81.17	121.33	0.0016**
A*S	10	11.65	1.17	1.74	N.S
A*T	10	9.79529	0.98	1.46	N.S
A*t	15	12.67122	0.84	1.26	N.S
S*T	4	3.01131	0.75	1.13	N.S
S*t	6	5.12284	0.85	1.28	N.S
T*t	6	5.61227	0.94	1.40	N.S
A*S*T	20	18.60330	0.93	1.39	N.S
A*S*t	30	27.06501	0.90	1.35	N.S
A*T*t	30	21.46929	0.72	1.07	N.S
S*T*t	12	11.98231	1.00	1.49	N.S
A*S*T*t	60	54.6	0.91	1.37	N.S
Error	60	4.82330	0.66		
Total	275	420.7623			

*Significant, ** Highly Significant, N.S : Non-Significant

Table 2a: Comparison of Individual Treatments Means of Dye Fixation (Post-treatment)

A	Mean	S	Mean	T	Mean	T	Mean
A1	1.31B	S1	1.61A	T1	1.31A	t1	1.29A
A2	1.30B	S2	1.52B	T2	1.30A	t2	1.29A
A3	1.25C	S3	1.46C	T3	1.29A	t3	1.31A
A4	0.98BC					t4	1.31A
A5	1.37A						
A6	1.38A						

Mean Value having different letters, differ significantly at 0.05 level of probability

SUGGESTIONS

The present results of the research study must be discussed with the industrial personnel for the enhancement of quality. It is not only to improve the quality of the product but the research also eco-friendly. After discussion the suggestions from the industrialist must be followed with respect to their problems and solve the problem with the help of research activities.

CONCLUSIONS

- The overall study revealed that after well pretreatments and dyeing process, for maximum cationic agents utilization, cationic agents applications were carried out under optimum level of controlling parameters.
- It was concluded that for maximum utilization of cationization, Indosol E-50 was found best at temperature 40°C for 25 min, Sandofix RSL cationic agent was also found best at temperature 40°C for 30 min.

- Best temperature 40°C for 20 min was examined best of cotton knitted fabric for all cationic agents types.
- Change of shade and dye fixation results were also good for all fabric types treated with different cationic agents.

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