



Characterization of dyeing performance for finished cotton fabrics using different dyes

S.F.Ibrahim, D.M.Essa and S.H.Samaha

National Institute of standards (NIS), Textile Metrology Lab.

ARTICLE INFO

Article history:

Received: 27 August 2011;

Received in revised form:

22 September 2011;

Accepted: 30 September 2011;

Keywords

Cotton fabrics,
Finishing agent,
Chitosan,
Acrylate monomers,
Dye, ability, Reactive dye,
Acid dye,
Optical density,
Colour parameters.

ABSTRACT

The present investigation aims to study and characterize the dyeing performance of cotton fabrics finished with finishing bath formulation containing emulsion lattices based on acrylate monomers, chitosan and polyethylene glycol (PEG) with improvement of dyeing properties with acid and reactive dyes. The finished cotton samples are examined and evaluated through measuring nitrogen content and the Fourier transform infrared spectra (FTIR). Evidences of finishing were obtained by IR from the appearance of CO bands absorbance and the reducing of relative intensity of OH, with respect to cotton. The dyeing performance of the finished cotton fabrics including testing of ; dye-ability(k/s), percentage dye fixation, colour parameters(L*,a*,b* and colour difference(ΔE) and estimated light fastness grades with respect to the different used chitosan concentration in the finishing bath formulation. The work involved also studying the effect of different dyeing times on all of the last stated parameters. The obtained results showed that dye-uptake increased by increasing chitosan concentration in the finishing bath , the applied reactive dye showed the highest percentage increase in both dye-ability and percentage dye fixation .In addition the estimated light fastness reating values of all of the examined fabrics where these rating grade values increased by increasing both chitosan concentration in the finishing agent and dyeing time .In addition , the applied acid dye recorded the highest light fastness values reaching (4-5) for (3.0g/l) chitosan after one hour dyeing compared to a rating value of (3)for blank fabrics assessed on standard gray scale.

© 2011 Elixir All rights reserved.

Introduction

Research on textile fibres is now increasingly being concentrated mainly on developing modified fibres having better properties than unmodified fibers⁽¹⁻³⁾. There are now –a-days numerous possibilities for modifying cotton fibers in order to improve their dyeing performance with different dye classes⁽⁴⁾. Where, Native cellulose consists of linear macromolecules formed by a hydroglucose units linked together by glucosidic bonds. Cellulose chains in the solid state are able to form intra and inter-molecular hydrogen bonds, leading to an organized chain structure⁽⁵⁾. Thus a native cellulosic fiber, such as cotton, can be regarded as a highly crystalline fiber, in which amorphous regions are formed by the most extended chains. Dye molecules cannot penetrate the highly ordered crystalline regions of native cellulose and their adsorption can only take place in the amorphous regions, which are highly ordered as well.^(6,7) chemical composition of fibers determines, to some extent, the type of best dye to be applied. Several types of dye-fiber interactions are reported in the literature, which involve; electrostatic, van der Waals bonding and hydrophobic interactions. As the primary hydroxyles of cellulose elementary units are responsible for the solubility and dye-ability of cellulosic materials, the formation of dye-fiber hydrogen bonds is controlled by the presence of hydrogen bonding functional groups in the fiber and the dye.

Chitosan (figure1) is a renewable biomaterial, highly viscous, chitosan, poly (1, 4) –2- amino-2 deoxy- B-D-glucose⁽⁸⁾. The degree of deacetylation (DD) and molecular weight of chitosan have the greatest influence on its physical and

chemical properties, including emulsification capacity, aggregation activity, rheological and physicochemical properties⁽⁹⁾. Due to the characteristic properties of chitosan such as nontoxicity, ecofriendly, biodegradability ,bioactivity and water binding capacity, chitosan and its modified analogs have found many applications in pharmaceutical and medical applications, textile dyeing and finishing.

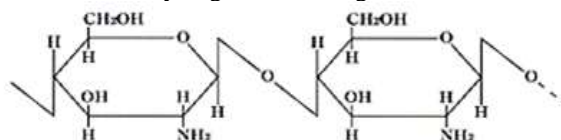


Figure (1) : Chemical structure of chitosan

In our present paper, we have investigated the characterization of the dyeing performance of cotton fabrics after their finishing with finishing bath formulation containing emulsion lattices based on acrylate monomers, chitosan and polyethylene glycol (PEG) with improvement of dyeing properties with acid , and reactive, dyes in terms of dye-uptake, percentage dye fixation, colour parameters; (L*,a*,b* and colour difference) and estimated light fastness grades with different concentration of chitosan.

Experimental work

Materials and chemicals:

Cotton fabric of 150g/m² treated with a solution containing 0.5g/l Egyptol non ionic detergent and 0.5g/l Na₂CO₃ at a temperature of 70°C for 1 h, thoroughly washed and air dried at room temperature.

Dyes: two different dye classes were applied in this work; Cibacron Blue (B-E), C.I. Reactive Blue 39 and Erionyl Yellow RXL C.I. Acid Orange 67, having the assigned chemical structures shown below. The absorbance spectrum of the aqueous solution of each dye along the visible range was determined separately for the definition, scanning and referring to the maximum wave length (λ_{max}) of each dye applied obtained scans (figures 2&3) were also shown below:

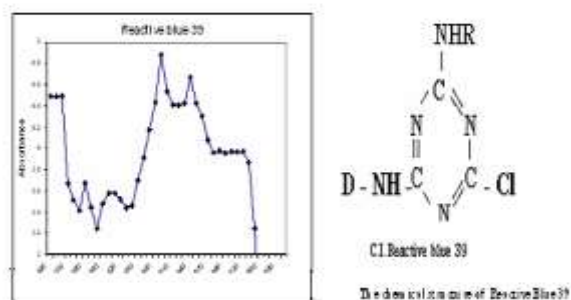


Figure (2) The absorption spectra of the Reactive blue 39 dye solution over a visible range. (λ_{max})=496nm.

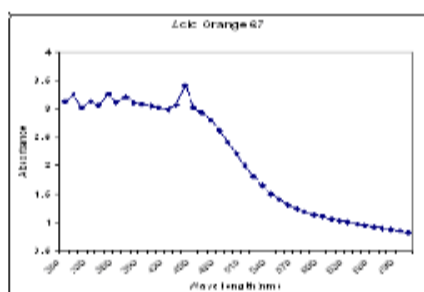
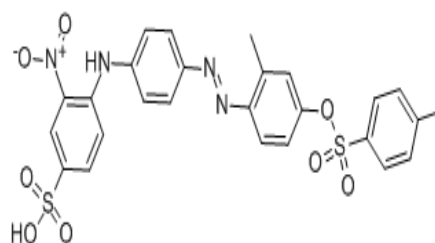


Figure (3) The Absorption spectra of the Acid Orange 67 dye solution over a visible range. (λ_{max})=409nm.



The chemical structure of Erionyl Yellow RXL C.I. Acid Orange 67

Preparation of finished cotton fabrics:

The cotton fabrics were independently treated with finishing bath formulations containing terpolymer emulsion lattice (5 g/l), chitosan [dissolved in acetic acid (w/w)] with concentration range (0.5, 1.0, 2.0 and 3.0 g/l) and polyethylene glycol (3.0 g/l) using the pad-dry method according to the previously stated method⁽¹⁰⁾. Finally the finished cotton fabrics was dried at 80°C for 5 min and cured at 130°C for 6 min. After treatment, the fabrics were soaped using [2.0] g/l nonionic detergent (Egyptol), washed with cold water and air dried. The estimated nitrogen content for the finished fabrics were found to be 0.56±0.07, 0.83±0.02, 0.94±0.06, and 1.31±0.05 for finished samples using (0.5, 1.0, 2.0 and 3.0 g/l) chitosan respectively.

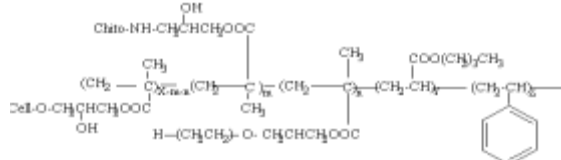


Figure 4. Chemical structure of finished cotton fabric

Dyeing Method

The finished cotton fabric samples with finishing bath formulations containing terpolymer emulsion lattice (5 g/l), chitosan [dissolved in acetic acid (w/w)] with concentration range (0.5, 1.0, 2.0 and 3.0 g/l) and polyethylene glycol (3.0 g/l) were independently dyed using two different dyes namely: Cibacron Blue (B-E) Reactive blue 39 and Erionyl Yellow RXL (C.I. Acid Orange 67), according to the conventional exhaustion method in a laboratory dyeing apparatus⁽¹¹⁾. The liquor ratio used was 1:50 and the dyeing bath contained separately each of the last mentioned dyes. The dyeing operation was allowed to proceed for different time intervals (3, 5, 10, 15, 20, 30 and 60 minutes). The dyeings were compared with those blank unfinished fabrics dyed according to conventional methods for dyeing both reactive and acid dye⁽¹¹⁾. The dyed samples were then washed with a solution of non ionic detergent [2.0 g/l] at 60°C for 15 minutes, rinsed with tap water and finally dried at ambient conditions.

Testing & Analysis

Infra-Red Spectroscopic Analysis

The IR spectra were recorded for blank unfinished and finished cotton fabrics the different examined samples using a Perkin Elmer FTIR spectrophotometer model 1650 made in the USA with a wavelength range of 4000-500 nm.

Nitrogen content determination:

The nitrogen content of the finished cotton samples was determined according to the reported method⁽¹²⁾.

Characterization of the dyed samples

The obtained coloured fabric samples are tested and analyzed through the following tests:

- Colour Strength (K/S) determination; these measurements were carried out using Colour Eye ® 3100 Spectrophotometer SDL, England. The colour strength (K/S) values of the different examined dyed samples were determined from the reflection spectra values at the proper wavelength according to Kubilka Munk Equation⁽¹³⁾.

- Determination of Percentage dye fixation; the percentage dye fixation of all of the examined dyed samples were calculated from the measured colour strength (K/S) values according to the reported equation⁽¹⁴⁾;

$$\text{Percentage dye fixation} = \frac{(K/S)_{t\text{-finished}}}{(K/S)_{B(\infty)}} \times 100$$

Where:

(K/S)_{t-finished}: colour strength of finished cotton fabric at each dyeing time

(K/S)_{B(∞)}: of blank one at infinite dyeing time (60minutes)

- Colour Parameters Determination; the colour parameters (L*, a*, b* and ΔE) were determined according to the CIE system, where: L* parameter represents the darkness -lightness axis of values from (0-100) i.e., black- white. The a* parameter runs from negative values (green) to positive values (red) while the b* axis runs from negative values (blue) to positive values (yellow), and the total colour difference (ΔE) values were calculated using CIELAB equation⁽¹⁵⁾.

- Light Exposure and Light Fastness Evaluation: the different examined printed samples are exposed to artificial daylight for 160 hours using Tera Light Fastness Tester⁽¹⁶⁾ at temperature 25 ± 2° C and relative humidity 65 ± 5% alongside with a Standard Blue Scale. The light fastness values are assessed in comparison with standard gray scale according to standard test method⁽¹⁷⁾.

Results and Discussion

Infra-Red Spectroscopic Analysis:

On comparing the IR spectrum of finished cotton fabric using finishing bath formulations containing: terpolymer emulsion (5 g/l), chitosan (3.0g/l) and polyethylene glycol

(3.0g/l) with that spectrum of blank unfinished samples as shown in figure 5(I&II), and in tables (1,2) we summarize the obtained peak intensity values of different functional groups that characterize the finished cotton fabric and blank unfinished samples. We noticed the characteristic functional bands at about; (1420,1100,1050) cm^{-1} , characterized the cellulosic structure⁽¹⁸⁾ in both fabrics. While additional bands appeared in the spectrum of finished cotton that are: carbonyl ester group of acrylates at about (1720 cm^{-1}), bands at (1600,1429,1451,757 and 699 cm^{-1}) for polystyrene confirming the presence of terpolymer functional groups⁽¹⁹⁾. Moreover, the absorption band at about 1492-1600 refer to N-H bending vibration for chitosan⁽²⁰⁾ which overlapped with the polystyrene band. Absorption bands at about 3500 for OH stretching and 1100 for C-O stretching of primary alcohols confirm the presence of polyethylene glycol (overlap with OH and C-O functional groups of cotton and chitosan respectively. Evidences⁽¹⁸⁾ of finishing were obtained from the appearance of CO bands absorbance and the reducing of relative intensity of OH, with respect to cotton.

Effect of chitosan concentration at different time intervals on the dye-ability and percentage dye fixation of the examined samples:

Tables (3&4) showed the changes in the dye-ability with chitosan concentration in the range (0.5, 1.0, 2.0 and 3.0 g/l) – for dyed cotton samples using: reactive blue 39 and acid orange 67. It is clear that regardless of dye type, the dye-ability increased by increasing chitosan concentration in the studied range without any steady state or level off, where it is well known that the treatment of cotton with chitosan imparts cationic character to the finished cotton fabric due to the abundant amino groups on its molecular structure (figure 1). Also as it was seen from the experimental section that the nitrogen content on the finished fabrics were increased from 0.56 ± 0.07 , to 1.31 ± 0.05 by increasing chitosan concentration in the finishing bath form (0.5g/l to 3.0 g/l), besides, to the evidences from FTIR results that detected the presence of additional groups for the terpolymer–chitosan finishing of cotton in addition to the reduction of IR intensity of OH group as discussed before in the IR discussion item. Also, imparting and/or increasing the cationizing character of cotton fabrics suitable for a) increasing hydrogen bond interaction between acid dye and finished cotton fabrics, b) self catalyzing the nucleophilic substitution reaction between the reactive dye and finished cotton fabrics, and c) increasing the swell-ability of the finished fabrics. It is important to mention that the dyeing with the reactive dye was carried out without addition of alkaline catalyzing agent in dyeing bath; As a result, there was a significant difference in the dye-up take for reactive dyeing between finished cotton samples and the unfinished blank ones. For acid dye, there is a little or low dyeing affinity of unfinished cotton fabrics towards dyeing, this could be recognized due to⁽¹⁰⁾ the chemical structure of the dye and/or weak physical adsorption of its molecules in the vacancy of cellulosic fabric under pH conditions.

On considering the effect of dyeing time on the dye-ability, the results obtained demonstrated the (K/S) values increased by increasing the contact time in the studied range. Where it is well known from the dyeing theory that the fixation process of the dye to cotton fabric samples involves the transport of dye molecules from bulk solution across a porous surface layer within the fiber next to the solution, and then into the bulk fiber. So increasing contact time in the studied range for the given acid and reactive dyes would certainly⁽⁶⁾ propagate the possible

interactions (hydrogen bond and/or electrostatic) and chemical covalent bond respectively.

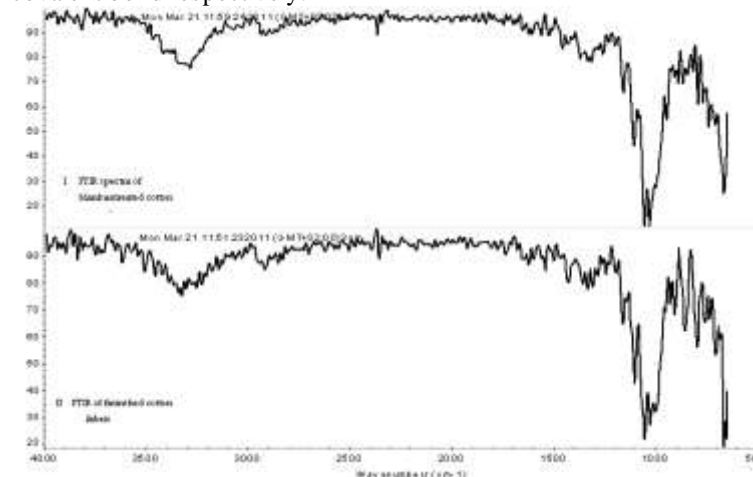


Figure 5. FTIR spectra of different examined cotton samples

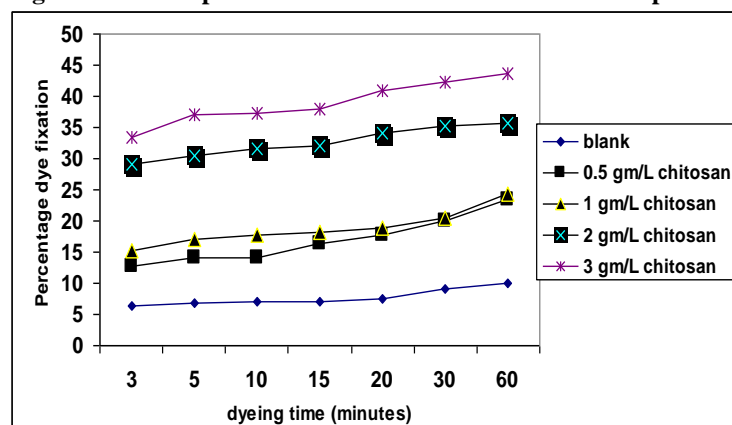


Figure 6. Variation in percentage fixation of reactive dye on different examined fabrics at different dyeing time

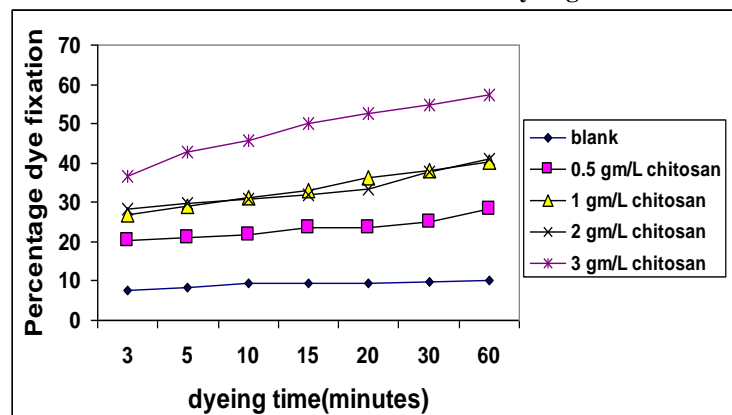


Figure 7. Variation in percentage fixation of acid dye on different examined fabrics at different dyeing time

In turn of dye type, the obtained results signified that the percentage increment in dye-ability of the finished cotton fabrics using 3.0 g/l chitosan concentration –as a selected sample- after 3 minutes recorded by about 51.21% for reactive dye against only about 38.5% for acid dye. Thus, figures (6&7) showed the change in the percentage dye fixation of each of three aforementioned dyes with each of; chitosan concentration in the finishing agent, dyeing time and nature of that dye applied. These results showed that, percentage fixation values increased by increasing both of the chitosan concentration in the finishing agent and the dyeing time regardless to the nature of the dye.

Table 1. Variation in IR band intensities of blank unfinished fabric

Wave numbers (cm ⁻¹)	Characteristic bands	Peak intensity value
3300	OH-stretching	75.312
2900	CH -stretching vibration	88.562
1427	CH bending	84.746
1100	C-O stretching	43.751

Table 2. Variation in IR band intensities of finished cotton fabric

Wave numbers (cm ⁻¹)	Characteristic bands	Peak intensity value	Overlap with
3300	OH-stretching	74.781	Overlap with 3500 OH group of primary alcohols in PEG
2900	CH -stretching vibration	84.691	-----
1726	carbonyl ester group of acrylates	90.312	-----
1600	for polystyrene confirming the presence of terpolymer functional groups	88.416	-----
1429		79.826	-----
1451		87.954	-----
757		64.913	-----
699		52.754	-----
1492-1600		to N-H bending vibration for chitosan	80.637
1100	C-O for primary alcohols in PEG	41.914	Overlap with C-O of chitosan

Table 3. Variation in dye-ability (K/S) values of the blank cotton samples and different chitosan concentration finished cotton fabrics dyed with reactive dye at different dyeing time.

Dyeing Time	K/S values of:				
	Blank	0.5 g/l chitosan	1.0 g/l chitosan	2.0 g/l chitosan	3.0 g/l chitosan
3	0.1257	2.4923	2.9944	5.6924	6.5633
5	0.1337	2.7462	3.3562	5.9645	7.2586
10	0.1364	2.7793	3.4633	6.1846	7.3083
15	0.1375	3.1827	3.5640	6.2774	7.4191
20	0.1477	3.4609	3.6836	6.6802	7.9921
30	0.1802	3.9152	3.9876	6.8910	8.2762
60	0.1958	4.5843	4.7788	6.9906	8.5430

Table 4. Variation in dye-ability (K/S) values of the blank cotton samples and different chitosan concentration finished cotton fabrics dyed with acid dye at different dyeing time.

Dyeing Time	K/S values of:				
	Blank	0.5 g/l chitosan	1.0 g/l chitosan	2.0 g/l chitosan	3.0 g/l chitosan
3	1.0761	2.9228	3.8099	4.0322	5.2285
5	1.1767	3.0127	4.1407	4.2351	6.1075
10	1.3385	3.1265	4.4633	4.3831	6.4962
15	1.3498	3.3392	4.7258	4.5522	7.1346
20	1.3642	3.3831	5.1832	4.7775	7.5041
30	1.4056	3.5611	5.4087	5.3607	7.8312
60	1.4269	4.0254	5.7219	5.8303	8.1681

Table 5. Variation in colour parameters of the blank cotton samples and different chitosan concentration finished cotton fabrics dyed with reactive dye at different dyeing time.

Dyeing Time	Blank				0.5 g/l chitosan				1.0 g/l chitosan				2.0 g/l chitosan				3.0 g/l chitosan			
	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)
3	84.81	2.56	-4.69	19.53	54.75	-3.19	-26.23	49.57	51.34	1.37	-20.58	48.81	38.02	2.58	-20.55	62.04	48.65	1.36	-20.06	57.95
5	84.28	2.73	-4.77	19.59	52.67	-3.07	-24.75	49.75	47.71	1.65	-20.61	49.14	40.72	1.55	-26.9	61.17	37.91	2.49	-19.73	61.87
10	84.15	2.77	-15.2	20.11	53.5	-2.56	-28.42	51.81	46.06	1.72	-20.89	53.75	40.31	0.37	-26.25	62.6	36.37	3.54	-20.81	63.73
15	83.57	3.24	-3.62	20.36	50.98	-2.39	-27.19	52.43	45.37	1.61	-20.15	54.03	39.8	0.89	-25.08	61.76	35.28	-2.93	-19.49	64.26
20	83.53	2.74	-5.14	20.68	49.59	-2.32	-26.53	53.26	45.03	2.73	-21.95	55.18	39.14	0.7	-24.91	62.76	33.48	3.57	-19.41	66.11
30	81.89	2.67	-6.19	22.11	47.66	-1.86	27.15	55.21	44.36	2.13	-20.59	55.21	38.95	1.24	-31.09	63.99	33.54	3.83	18.33	65.58
60	80.61	-0.82	-6.62	22.67	44.86	-1.67	-25.79	56.9	44.31	1.35	-20.31	55.11	37.48	0.81	-24.91	64.11	33.16	4.11	-20.14	66.57

Table 6. Variation in colour parameters of the blank cotton samples and different chitosan concentration finished cotton fabrics dyed with acid dye at different dyeing time.

Dyeing Time	Blank				0.5 g/l chitosan				1.0 g/l chitosan				2.0 g/l chitosan				3.0 g/l chitosan			
	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)	L*	a*	b*	Colour difference (ΔE)
3	83.15	5.87	33.19	1.23	79.54	7.24	51.88	14.4	77.75	12.29	59.96	22.37	77.23	11.24	55.58	18.75	69.23	276	62.99	25.64
5	82.51	7.42	36.36	1.66	79.11	9.28	52.88	15.92	76.17	15.21	57.63	23.11	75.41	13.57	54.28	20.78	70.96	23.96	61.71	29.21
10	82.32	7.48	38.05	1.71	78.29	11.17	53.02	16.07	76.41	16.61	60.36	25.38	74.57	16.42	60.67	25.94	67.98	23.89	59.71	31.03
15	81.03	8.23	38.61	1.99	78.03	12.01	53.97	18.62	75.92	17.33	61.27	26.48	74.07	15.76	59.57	24.58	68.85	25.69	63.28	30.66
20	80.73	8.71	39.19	2.38	77.46	13.59	55.39	18.68	75.29	17.71	61.97	28.43	74.38	16.07	60.09	28.23	70.6	22.73	60.03	33.91
30	80.21	9.04	39.32	3.75	77.14	13.93	57.28	20.12	74.23	19.25	62.48	28.81	73.56	16.83	58.74	23.86	69.51	24.58	64.38	33.05
60	80.19	10.57	39.34	5.02	75.53	14.76	57.67	21.62	72.64	21.03	64.91	29.69	73.49	21.46	55.56	21.38	71.97	23.89	59.71	30.66

Table 7. Variation in light fastness of reactive dye on blank cotton samples and different chitosan concentration finished cotton fabrics at different dyeing time

Dyeing Time	light fastness of*:				
	Blank	0.5 g/l chitosan	1.0 g/l chitosan	2.0 g/l chitosan	3.0 g/l chitosan
3	2	2	2/3	3	3/4
5	2	2	2/3	3	3/4
10	2	2	2/3	3	3/4
15	2	2	2/3	3	3/4
20	2/3	2	2/3	3	3/4
30	2/3	2	2/3	3	3/4
60	2/3	2	2/3	3	3/4

*light fastness assessment was carried out on comparison with standard gray scale on the basis of standard method ⁽¹⁷⁾ where grade rating range from 1-5, i.e., grade 5 represents the highest fastness, while grade (1) is the lowest

Table 8. Variation in light fastness of acid dye on blank cotton samples at different dyeing time. and different chitosan concentration finished cotton fabrics at different dyeing time

Dyeing Time	light fastness of*:				
	Blank	0.5 g/l chitosan	1.0 g/l chitosan	2.0 g/l chitosan	3.0 g/l chitosan
3	3	4	4	3/4	4
5	3	4	4	4	4
10	3	4	4	4	4
15	3/4	4	4	4	4
20	3/4	4	4	4	4/5
30	3/4	4	4	4/5	4/5
60	3/4	4	4	4/5	4/5

*light fastness assessment was carried out on comparison with standard gray scale on the basis of standard method ⁽¹⁷⁾ where grade rating range from 1-5, i.e., grade 5 represents the highest fastness, while grade (1) is the lowest

On considering the effect of dye nature on the change in the percentage fixation it is clear that reactive dye recorded the highest percentage fixation values that calculated; (10&43.63%), for (blank &3.0 g/l-chitosan finished cotton respectively acid dye. While acid dye percentage fixation values calculated by; (1&5.72%), for (blank &3.0 g/l-chitosan finished cotton respectively. These findings could be recognized due to⁽¹⁰⁾ the following criteria; i) availability of fabric basic character to enhance chemical bond with reactive dye over hydrogen and /or electrostatic bonds with acid dye, ii) chemical structure configuration, molecular weight or affinity of the studied dyes to be adsorbed, aggregated, accumulated or diffused through fiber intermicelle which in turn affect percentage dye-ability between blank and finished fabric with cationizing agent.

The change in the colour parameters

Tables (5&6) showed the changes in the colour parameters (L^* , a^* , b^* and ΔE), where: L^* parameter represents the darkness-lightness axis of values from (0-100) i.e., black-white. The a^* parameter runs from negative values (green) to positive values (red) while the b^* axis runs from negative values (blue) to positive values (yellow), and the total colour difference (ΔE) values. These results showed that L^* parameter values decreased by increasing both of chitosan concentration in the finishing agent and dyeing time relating to the fact that^(21&22) increasing both of chitosan concentration and dyeing time increases dye up take causing the colour to be more darker indicating more dye-ability, regardless of the dye nature. Also the results showed that both the colour component a^* and b^* almost increased by increasing both of chitosan concentration in the finishing agent and dyeing time regardless of the dye nature indicating more dye-ability of all finished fabrics. Where, for acid yellow dye we notice that the b^* parameter became more positive indicating more yellow part in dye colour and also more positive (a^*) parameter indicating more red in colour and the combination of (a^*) and (b^*) changes thus evaluating the increase in colour part of the yellow colour of this acid dye, this could be explained in terms of the adsorption of acid dye by finished cotton. While for reactive dye the (b^*) parameters values became more negative indicating more blue part in the colour by increasing both of chitosan concentration in the finishing agent and dyeing time.

The change in colour difference (ΔE) and light fastness values

The changes in the colour difference (ΔE) -which were calculated as the energy difference between blank unfinished cotton fabrics and those finished with chitosan at different concentration- are clarified in tables (5&6), these results showed that the colour difference (ΔE) values increased almost by increasing both chitosan concentration in the finishing agent and dyeing time indicating more dye-ability. This behaviour was verified by estimating the light fastness rating values of all of the examined fabrics as shown in tables (7&8) where these rating values increased also by increasing both chitosan concentration in the finishing agent and dyeing time. In addition, the applied acid dye recorded the highest light fastness values reaching (4/5) for (3.0g) chitosan after 60 minutes dyeing compared to a rating value of (3) for blank fabrics. This fastness for the applied acid dye can be discussed in terms of chemical structure of this dye (figure 3) and that of finished cotton (figure 4) which may have caused the dye to be tightly adhered to the finished fabrics to the degree that caused this observed improve in light fastness.

Conclusions

The estimated nitrogen content for the finished fabrics were found to reach 1.31 ± 0.05 for finished cotton 3.0 g/l chitosan in the finishing bath, indicating the increase in cationic character of finished cotton. Evidences could be obtained from FTIR of finishing were obtained from the appearance of CO bands absorbance and the reducing of relative intensity of OH, with respect to cotton. The obtained results showed also that dye uptake increased by increasing chitosan concentration on the finishing bath i.e., which results in the enhanced dye-up take regardless of dye class used. In turn of dye class nature the results showed that a highest percentage increase in dye-ability as well as percentage dye fixation of all fabrics obtained for those dyed by reactive dye. By estimating the light fastness rating values of all of the examined fabrics where these rating values increased also by increasing both chitosan concentration in the finishing agent and dyeing time. In addition, the applied acid dye recorded the highest light fastness values reaching (4/5) for 3.0g/l chitosan in the finishing bath after one hour dyeing compared to a rating value of (3) for blank fabrics.

References

- Heping Xiong, Yuande Peng, Shouwei Tang, 2008, "Study on the performance of ramie fiber modified with ethylenediamine", Carbohydrate Polymers 71, Zhao-Tie Liu a,*, Yan Yang a, Lili Zhang a, Ping Sun a, Zhong-Wen Liu a, Jian Lu a, pp; 18–25
- Broadbent, A. D., The'rien, N., & Zhao, Y. F. 1995, "Effects of process variables on the fixation of reactive dyes to cotton using infrared radiation", Industrial and Engineering Chemistry Research, 34, pp;943–947.
- Da Silva Filho, E.C., de Melo, J.C.P., Airoidi, Claudia, 2006, "Preparation of ethylenediamine-anchored cellulose and determination of thermo-chemical data for the interaction between cations and basic centers at solid/liquid interface". Carbohydrate Research, 341, pp;2842–2450.
- Dela Orden, M. U., & Urreaga, J. M. 2006. "Photooxidation of cellulose treated with amino compounds". Polymer Degradation and Stability, 91pp;2053–2060.
- Wadsworth, L. C. and Cuculo, J. A., 1978, "Determination of accessibility and crystallinity of cellulose", In Modified Cellulosics. Ed. R. M. Rowell, and R. A. Young. Academic Press, New York.
- Pier L. B., Antonella C., Elena S., Andrea M., Giovanni T., Anna M. B. & Alberto S. 1998, "Dyeing of Cotton in Supercritical Carbon Dioxide" Elsevier Science Ltd, Dyes and Pigments, Vol. 39, No. 4. ^a Dipartimento di Chimica Fisica ed Elettrochimica, University.
- Burdett, B. C., 1989, "Physical chemistry essential to dyeing theory". In The Theory of Coloration of Textiles, 2nd edn., Ch. 1, ed. A. Johnson. The Society of Dyers and Colourists, Bradford, x, pp.1-96)
- John F. Hartmann,† and Janos Borbely, 2005, "Preparation and Characterization of Chitosan-Based Nanoparticles" Magdolna Bodnar, Department of Colloid and Environmental Chemistry, University of Debrecen, H-4010 Debrecen, Hungary, ElizaNor Polymer LLC, Princeton Junction, New Jersey 08550, BBS Nanotechnology Ltd., H-4225 Debrecen, P. O. B. 12, Hungary Received March 25.; Revised Manuscript Received June 13
- Berth, G.; Dautzenberg, H.; Peter, M. G. 1998, "Physico-chemical characterization of chitosans varying in degree of acetylation" Carbohydrate Polymer., 36, pp;205-216.

- 10- H.E. Nasr, 2005, "Preparation and Characterization of Some Terpolymer Latices and their Application as Finishing Agents for Cotton Fabric". *Polymer-Plastics Technology and Engineering* Volume 44, Issue 2.
- 11- Giles, C.H., Datner, A., Duff, D.G., Sinclair, R.S. & Stens, C.B. 1974, 'A Laboratory Course of Dyeing', Society of Dyers and Colourists., Third Edition. Bradford, Yorkshire.
- 12- A.I. Vogel, 1975, *Elementary Practical Inorganic Chemistry*, 2nd edition, Longman, London, Part 3, pp:652
- 13- AATCC, Standard Method 26, 1991 "Colour Measurement, Principles and the Textile Industry (Research Triangle Park), NC.
- 14- Hawkyard, C.J., Shao, J., & Carr, C.M. 1997, 'Investigation into the Effect of UV/ozone Treatments on Dye-ability and Printability of Wool', *Journal Society of Dyers and Colourists*, Vol. 113, pp. 126-130.
- 15- McLaren K. 1983 "The Colour Science of Dyers and Pigments" Adam Hilger Ltd., Bristol, pp. 62.
- 16- Tera Light Fastness Tester, 1981 Egyptian Patent No. 15182.
- 17- ASTM, Standard Method, 1990- G 23.
- 18- H.E. Nasra, S.M. Sayyahb, D.M. Essa, S.H. Samaha and A.M. Rabied, 2009, "Utilization of acrylates emulsion terpolymer with chitosan as a finishing agent for cotton fabrics", *Carbohydrate polymers*, 76, pp;36-45.
- 19- Liu Yeqiu, Hu Jinlian, Zhu Yong, and Yang Zhuohong, 2005 "Surface modification of cotton fabric by grafting of polyurethane" *Carbohydrate Polymers* Volume 61, Issue 3, 29 August, pp; 276-280
- 20- Shin, Y. & Yoo, D.I. 1998, "Use of chitosan to improve dyeability of DP-finished cotton (II) *Journal of applied polymer science*, 67, 1515-1521.
- 21- E.A. El-Alfy, S.H. Samha, J.M. Aboul-Fetoh and F.M. Tera, 1998 "Chemical modification of cellulose for dyeing with disperse dyes" *Colourage Journal*, January, pp; 23-28.
- 22- Sang-Hoon Lim and Samuel M Hudson, 2004 "Application of a fiber-reactive chitosan derivative on cotton fabric as a zero-salt dyeing auxiliary. *Coloration Technology*, 120: pp; 108-113.