IMPROVING COLOR SHADE DEPTH OF CHITOSAN-TREATED COTTON FABRICS FOR DIGITAL TEXTILE PRINTING

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1. INTRODUCTION

The digital textiles printing (DTP) revolution has already started in the globalized manner. Textiles market trends require a much higher efficient and accurate business to cope with the demand of individual stylish, the demand of new product designs frequency, the small order for each design, the large variety, and the "quick response" to the market, the time base competition, and DTP meets the consumer market's desire for the traditional artworks in the innovated way. On the top of all these, there is a demand for the ecological thoughts, the relationships between plants, animal, people and their environment and the balances among these relationships, in wears and environmental concerns. Chitosan is right here to fullfill the human's requirement of eco-friendly environmental material in form of chitosan-treated cotton ready for DTP.

The quality of DTP is now facing with many problems in color quality and dye adsorption onto cotton fabric. Beside other fact such as printing inks and technology, fabric pre-treatment play an important role in the successful of DTP vision. In this work, chitosan is used as the pre-treatment agent on cotton fabric. Chitosan, a -(1,4)-linked polysaccharide of D-glucosamine, is the deacetylated derivative of chitin that is indirectly obtained from waste materials from the seafood industry such as shells of shrimp, crab, and lobster. Besides the well-known antimicrobial finishes on textile goods, chitosan, a natural biopolymer, has many chemical attributes, especially its polycationic nature, making it an interesting choice for these applications in the trend of eco-friendly processes that reduce auxiliaries used in dye-house.

The result will show in this paper, chitosan used as an agent to improve the color shade depth and the rate of dye adsorption in dyeing and printing industry.

The specific objectives of the work are: 1) to approve the improvement in rate of adsorption of chitosan-treated cotton fabrics in dyeing with reactive dyes; 2) to figure out the different thickeners prior to DTP; 3) to apply the chitosan-treated cotton fabric in DTP, also to examine the improvement in color shade depth (K/S values) of printed samples.

2. EXPERIMENTALS

2.1. Materials

Materials used for three stage are unique in the fabrics and chitosan, other chemicals and agents are different depends on the experiment. A commercial grade (deaceylated of minimum 90%) of 12.6 cps chitosanca. 3.1 x 10^4 purchased at TeaHun Bio Co.Ltd. The cotton fabrics used in the present were well desized, scoured and bleached. Reactive dyes and prints, Alginate used as the thickener preparation for cotton fabrics for Digital Textiles Printing, the alginic acid_sodium salt (abbr. alginate) purchased from Aldrich, the viscosity: 200.000~400.000cps. Urea NH_2CONH_2

2.2. Pretreatments of cotton fabric for DTP

In order to improve the color shade depth in digital textile printing, cotton fabrics were pre-treated in different methods. In the table 3 shows the sample fabrics preparation for DTP, chitosan concentration applied onto the surface of cotton was 1.1%, then chitosan-treated cotton fabric padded with different solution contents alginic acid_sodium salt 2%, sodium silicate solution 1%, and silicone emulsion 2%, urea 1%, and alkali (sodium bicarbonate) 0.5%.

3. RESULTS AND DISCUSSION

3.1. Chitosan coated cotton fabric:

Cotton is a major source of cellulose, which has been known to have good physical properties and has widely used as construction material, paper and clothes. Chitosan has the same backbone as cellulose, except the (C-2) amino group on chitosan and the (C-2) hydroxyl group on cellulose. Chitosan dissolved in dilute acetic acid, can applied to cotton by three different methods; pad-batch (30 min) - rinse, pad-dry (3min at 150°C) - rinse, and exhaustion (20 min at 40°C, liquor ration 28:1) – rinse (6). The mechanism of filming chitosan onto the cotton substrates is as followed. Because of the similar structures of chitosan and cotton, there is the Van der Waals' forces between the two. Another possibility mentioned for the binding chitosan to cellulose was the cross-linking by formation of Shiff base between cellulose's reducing end (-CO-H) and the amino group of chitosan (25) In addition to the two possible bindings, hydrogen bonds should play an important role.

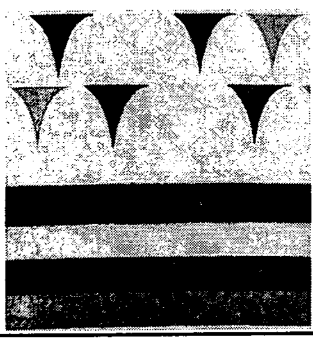
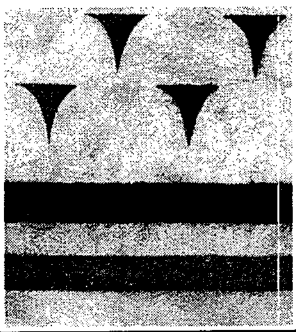
3.2. Chitosan as improving agent in dyeing and printing

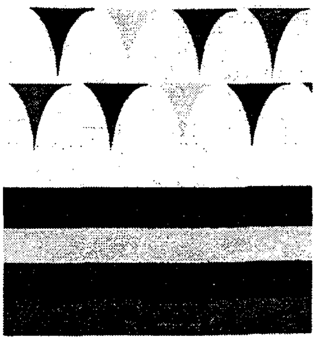
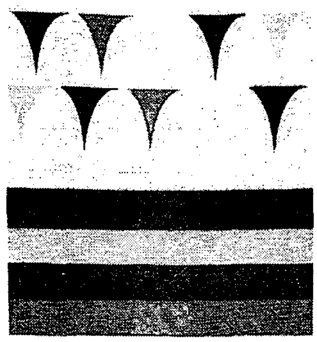
When alkali was added to the dyebath, a substantial quantity of dye was available for reaction with cotton. Similarly to cotton, chitosan with the present of accessibility of hydroxyl group in chitosan (R - CH_2OH) in dyeing process , there can be explain by the deprotonation of the hydroxyl group occurred under caustic conditions just as the Cell-OH deprotonation. The covalent bonds reaction between the reactive group of dye and chitosan taken place as followed.

3.3. Results of DTP with chitosan-treated cotton fabric compare to non chitosan-treated cotton

No.	Samples	Samples	Cyan(C)	Magenta(M)	Yellow(Y)	Black(K)
1	O	cotton no treatment	1.587	4.0401	0.8583	4.09518
2	A	chitosan-treated cotton	7.2406	8.3378	3.1995	7.9067
3	A-patent	chitosan-treated cotton padded solution of Dyetec patent	15.9639	9.5722	5.6256	9.6844
4	patent	cotton padded solution of Dyetec patent	15.7374	8.5501	5.3686	8.5140
5	ABCD	chitosan-treated cotton padded solution of alginate-urea-alkali	11.4579	12.3877	8.5140	13.7229
6	BCD	cotton padded solution of alginate-urea-alkali	8.8486	9.83109	5.7666	10.4429

Table 17. Rate of color strength improved of printed chitosan-treated to untreated cotton

<table>
<tr><th colspan="2">Color Difference CIE L* a* b* _ D65-10</th><th rowspan="2">Color</th><th rowspan="2">Rate of color strength improve (%)</th></tr>
<tr><th>Targetsample: Chitosan-treated cotton(#1)</th><th>Batch sample: No Chitosan-treated cotton fabric(#2)</th></tr>
<tr><td rowspan="4"></td><td rowspan="4"></td><td>(C) Cyan</td><td>78.1</td></tr>
<tr><td>(M) Magenta</td><td>80.2</td></tr>
<tr><td>(Y) Yellow</td><td>89.9</td></tr>
<tr><td>(K) Black</td><td>92.8</td></tr>
</table>

Color Difference CIE L* a* b* _ D65-10		Color	Rate of color strength increase (%)
Target sample: **Chitosan-treated** cotton fabric padded solution of alginate-urea-alkali	Batch sample: **No Chitosan-treated** cotton fabric padded solution of alginate-urea-alkali		
		(C) Cyan	22.8
		(M) Magenta	20.64
		(Y) Yellow	32.3
		(K) Black	23.9

4. CONCLUSION

Chitosan-treated cotton fabric has been approved for its advantages in color strength improvement in dyeing and digital textile printing. The 1.1% concentration of chitosan (Mw= ca. 3.110^{4}) applied onto cotton surface for the best K/S value was the result of experiment.