IOSR Journal of Polymer and Textile Engineering (IOSR-JPTE)
e-ISSN: 2348-019X, p-ISSN: 2348-0181, Volume 5, Issue 5 (Sep. - Oct. 2018), PP 01-10
www.iosrjournals.org

Experimental Investigation for Improving the Wash Fastness of Optical Brightening Agent (OBA) on Cotton Knitted Fabric

Moni Sankar Mondal[1]. Naim Hassan,Md[2]. Imrul Hussain Sakib[3]. Pavel Sarkar[4]
Department of Textile Engineering, Khulna University of Engineering &Technology
Khulna-9203, Bangladesh
Corresponding Author:Moni Sankar Mondal

Abstract : *The main concern of this project work was to increase the wash fastness value of whitening fabric. In this project work the cotton fabric was treated in three different methods using synthetic optical brightening agent, Cationic Pretreatment of cotton fabric and application of green resource (vinegar and Lemon Juice) as alternative of synthetic agent. Six different concentrations (0.5-3%) of synthetic Optical brightening agent were used for assessment of wash fastness values but experimental data showed the concentrations have not visible influence to increase the fastness value rather than it decreases the wash fastness value after certain limit .On the other hand, the effect of cationic modification on cotton fabric was noticeable. The cationization of cotton fabric was performed at 60°C and 80°C for three different concentrations such as 5g/l, 10g/l &15g/l. The result showed the possibility of getting better wash fastness values at 80°C than 60°C. Whereas, concentrations have minimal influences when compared among them at fixed temperature. To get better wash fastness values of white cotton fabric, one of the approach in this workwas to use green resources (lemon, vinegar) of optical brightening agent with or without cationic pretreatment. The wash fastness values for lemon and vinegar treated fabrics were higher when cationic pretreatment was done. Moreover satisfactory brightening effect was found for green optical brightening agent during visual assessment under UV light.*

Keywords *–Synthetic optical brightening agent, Cat ionization,Lemon juice,Vinegar juice,Wash fastness.*

Date of Submission: 15-09-2018 Date of acceptance: 30-09-2018

I. Introduction

Optical brighteners, optical brightening agents (OBAs), fluorescent brightening agents (FBAs) or fluorescent whitening agents (FWAs) are dyes that absorb light in the ultraviolet and violet region (usually 340-370 nm) of the electromagnetic spectrum, and re-emit light in the blue region (typically 420-470 nm). These additives are often used to enhance the appearance of color of fabric and paper, causing a "whitening" effect, making materials look less yellow by increasing the overall amount of blue light reflected [1][6][8].

Optical brighteners are chemicals added to your laundry detergent, often unlabeled, to make your clothes appear brighter. Corn allergic/intolerant individuals avoid most laundry detergent due to the chemicals added for scents and corn derived surfactants, however most have not considered the problematic optical brighteners in their "Free and Clear" laundry detergents. Most optical brighteners are made from benzene (a known carcinogen) [2].

The washing fastness of fluorescent brighteners is medium due to their lack of substantively of textile materials and their gradual degradation by exposure to sunlight. With a view of improving the wash fastness of optical brightening agent different experimental investigation is followed. ThePercentage variation of OBA in the recipe is checked out.Then the introduction of cationic sites within the cellulose is the most expected technique to increase the dye adsorption. Cationic sites can be introduced either by aminization or cationization. Cationization is one of the most important modifications for cellulose.As optical brightening agent has a health hazardous issue, so we make a concern to evaluate a green resource to it which can be a replacement of synthetic optical brightening agent at a scale of small production [3].Cellulosic materials are commonly cationized in three ways: firstly, a direct cationization of cellulose using a chemical compound with suitable functional groups that react with cellulose hydroxyl groups. The second approach involves the addition of binding agent, such as dimethyloldihydroxyethylene urea, which reacts both with cellulose hydroxyl and the functional group of cationic agent. This process is mainly used for textile application since the common textile pad-dry-cure process can be employed. The third approach utilizes graft polymerization to introduce monomeric or polymeric cationizing agents within the cellulose, but it is not commercially applicable. Each process has advantages and disadvantages, but none of these processes has been commercially adopted yet [4].

The problem with using these chemicals as optical brighteners, is that they're designed to bind to the clothing and remain. If you were able to rinse them off, they wouldn't be doing their job. Because they remain on your clothing and sheets, they come into regular contact with your skin. This is not healthy for your skin and can cause rashes, irritations, and sensitivities. Also, since they are not readily biodegradable, they can be harmful to fish and other animals and plants.Not only can they be harmful to your skin, they can also cause your clothes to feel stiff unless fluffed in the dryer or washed with a fabric softener. Laundry washed without optical brighteners will feel much softer even if line dried[5].

Optical brighteners are chemicals that make fabrics seem brighter or whiter than they are. They remain behind on clean laundry as a coating of microscopic fluorescent particles. When invisible ultraviolet light hits these particles, they convert it into visible light to create an optical illusion that tricks the eye into thinking our clothes are super clean. Many optical brighteners are derived from benzene, a very toxic compound. In addition, these chemicals generally don't break down in the environment and remain in the waters they're washed into, where they poison fish and other aquatic life. Optical brighteners can also cause allergic reactions in people via a process called photo toxicity. When they rub off on our skin from laundered clothes and come into contact with sunlight, they can create a rash or irritation that's mistaken for sunburn. By giving up optical brighteners , lemon juice,vinegar or mixed can be used as green alternative to bring the whitening effect on the fabric [7].

In case of optical brightening agent the wash fastness is measured by grey scale assessment and spectrophotometer after 1 or 2 times wash.In this study, the whitening processes were carried out by using synthetic optical brightening agent with or without cationization of cotton fabric and green resource as alternatives of synthetic brightening agent for investing the better washfastness values . The shade unevenness was assessment by visually.

II. Materials

The materials used in this work includes knitted fabrics, optical brightening agent, cationizer, pretreatment chemicals, washing chemicals, green alternatives. The details are given as follow**;**

2.1 Substrates

The specification of the fabrics are listed in Table 2.1

Table 2.1: Specification of the cotton fabric

Fabric	**Structure**	**CPI**	**WPI**	**Yarn type**	**Yarn count**	**Stitch length(mm)**	**GSM(g/m^2)**
Scoured-Bleached cotton fabric.	Single jersey	46	41	Carded	28s	2.70	160

For this work, single jersey scoured and bleached cotton fabric was supplied by Rupa Knitwear (Pvt.)Ltd., Kunia, Board Bazar, Gazipur, Bangladesh.

2.2 Optical Brightening Agent

For the work, we used the Pigment of Huntsman (Uvitex BMU-V) & the detail of OBA used in the project is given.

Table 2.2: Optical brightening agent used used

Product Name	**Brand Name**	**Form**	**Manufacturer**
OBA	UVITEX BMU-V	Liquid	Huntsman

2.3 Cationizer

For this work, Picat 250 Cationizer used from laboratory

Table 2.3: Cationizer used

Product Name	**Brand Name**	**Source**
Cationizer	Alquat-CF	Laboratory

2.4 Pretreatment chemicals

For this work, various types of fabric pretreatment chemicals used such as follows:

Table 2.4: Chemicals used in fabric pretreatment

Chemical Name	**Brand Name**	**Country Name**
Detergent	Marla OLS	Germany
Wetting agent	FELSON NOF	Germany

Anti-creasing agent	Marla KT	Germany
Caustic	Caustic	China
Soda Ash	Soda Ash	China
H2O2	H2O2	Chaina+Korea
Per Oxide Stabilizer	Kapazon H-53	Germany
Acetic Acid	Acetic Acid	India
Sequestering Agent	MS	China
Enzyme	BIOPOLISH	China

2.5 Other chemicals

For this work, various types chemicals used for green alternatives such as follows:

Table 3.5: Chemicals used for green alternative

Chemical Name	Function	Source
Baking soda	Whitening	Local store
Vinegar	Whitening	Local store
Lemon	Whitening	Local store

III. Methodology

3.1 Flow diagram of the experimental work

The main goal of the thesis work was analysis the whiteness, wash fastness and metameric test of optical brightening agent .The whole experimental work is shown step by step in the following line diagram (Fig.3.1).

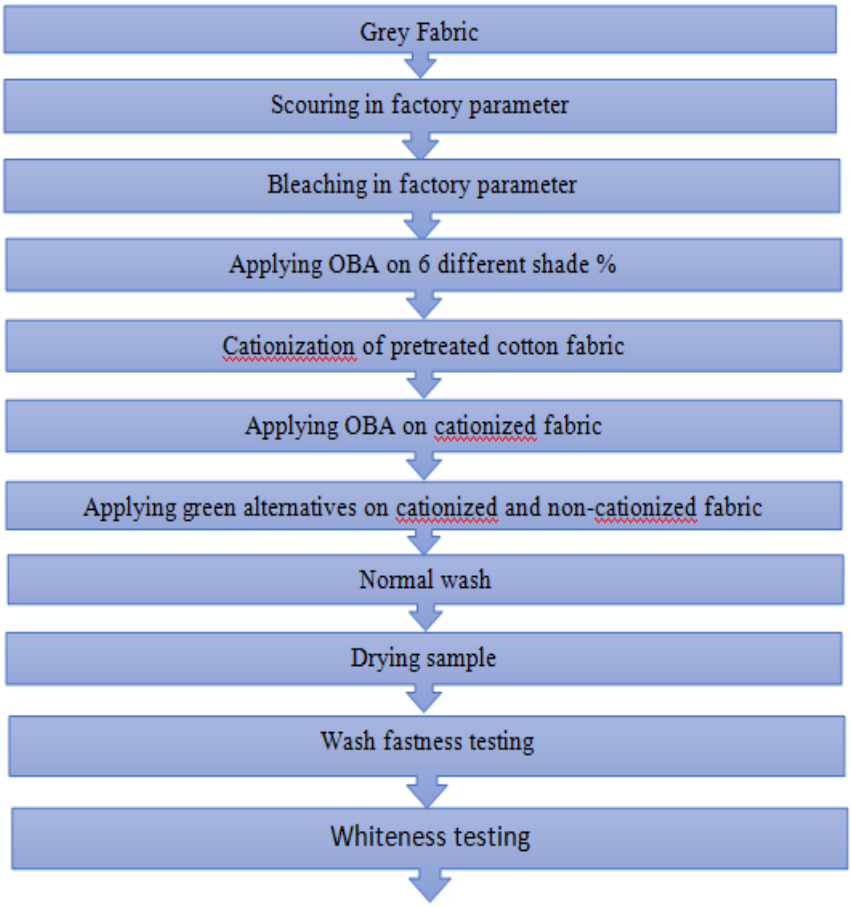

Fig. 3.1: Flow diagram of the experimental work

3.2 Equipment's used

The equipment's and test instruments were used in this thesis work are listed below

Table 3.1: List of Equipment's used

Name of Equipment's	Manufacturer	Experiment performed
IRE-24 Lab dyeing m/c	GESTAR ,China	Dyeing the fabric
Gyro-wash (Rotate wash fastness tester)	GESTAR ,China	Wash fastness testing(ISO -105 -C06)
GT-DO4 Electronic Crock-meter	GESTAR ,China	Rubbing fastness testing(ISO 105-X12)
High Precision Oven	Tony ,China	Drying the fabric
Ultra-vis spectrophotomer	Hunter-lab, USA	Checking the shade and fastness properties.

3.3 Recipe formulation

Ingredients	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6

For this work the amount of ingredients used and percentage details below:

OBA	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%
Detergent Agent	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L
Acetic acid	1cc/lit	1cc/lit	1cc/lit	1cc/lit	1cc/lit	1cc/lit
Sequestering agent	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L	2.5 gm/L
Anti-creasing agent	1 cc/lit	1 cc/lit	1 cc/lit	1 cc/lit	1 cc/lit	1 cc/lit
Caustic	2gm/L	2gm/L	2gm/L	2gm/L	2gm/L	2gm/L
H_2O_2	3gm/L	3gm/L	3gm/L	3gm/L	3gm/L	3gm/L
P^H	10 – 11	10 – 11	10 – 11	10 – 11	10 – 11	10 – 11
M:L	1:20	1:20	1:20	1:20	1:20	1:20
Time	40 min	40 min	40 min	40 min	40 min	40 min
Temperature	98°C	98°C	98°C	98°C	98°C	98°C

Table 3.2: Recipe for shade % of OBA

3.4 Recipe calculation

3.4.1 Amount of OBA for various shade %

Fabric weight = 7.5gm, M:L=1:20, Using 3% stock solution.

OBA (0.5%) = $\frac{7.5 \times 0.5 \times 100}{100 \times 3}$ = 1.25 ml

Amount of water = (150-1.25) ml = 148.75 ml

OBA (1.0%) = $\frac{7.5 \times 1 \times 100}{100 \times 3}$ = 2.50 ml

Amount of water = (150-2.50) ml = 147.5 ml

OBA (1.5%) = $\frac{7.5 \times 1.5 \times 100}{100 \times 3}$ = 3.75 ml

Amount of water = (150-3.75) ml = 146.25ml
OBA (2.0%) = $\frac{7.5 \times 2 \times 100}{100 \times 3}$ = 5.0ml
Amount of water = (150-5.0) ml = 145.00 ml
OBA (2.5%) = $\frac{7.5 \times 2.5 \times 100}{100 \times 3}$ = 6.25 ml
Amount of water = (150-6.25) ml = 143.75 ml
OBA (3.0%) = $\frac{7.5 \times 3 \times 100}{100 \times 3}$ = 7.5 ml
Amount of water = (150-7.5) ml = 142.5ml

3.4.2 Amount of cationizer for different concentration
Fabric weight = 7.50 gm, M:L=1:40
Cationizer (5 g/l) = $\frac{300 \times 5}{1000}$ = 1.5 ml
Amount of water = (300-1.5) ml = 298.5 ml
Cationizer (10 g/l) = $\frac{300 \times 10}{1000}$ = 3.0 ml
Amount of water = (300-3.0) ml = 297 ml
Cationizer (15 g/l) = $\frac{300 \times 15}{1000}$ = 4.5 ml
Amount of water = (300-4.5) ml = 295.5 ml

3.4.3 Green OBA
Fabric weight = 7.50 gm, M:L=1:20
Baking soda (20 g/l) = $\frac{150 \times 20}{1000}$ = 3 ml
Amount of water = (150-3) ml = 147 ml
Lemon (3%) = $\frac{150 \times 40}{1000}$ = 6 ml
Amount of water = (150-6) ml = 144 ml
Vinegar (3%) = $\frac{150 \times 40}{1000}$ = 6 ml
Amount of water = (150-6) ml = 144 ml

3.4.4 Washing Agent
Fabric weight = 4.0 gm, M:L=1:50
ECE detergent (3 g/l) = $\frac{200 \times 3 \times 100}{1000 \times 10}$ = 6 ml
Amount of water = (200-6) ml = 194 ml
Sodium perborate (1 g/l) = $\frac{200 \times 1 \times 100}{1000 \times 10}$ = 2 ml
Amount of water = (200-2) ml = 198 ml

3.5 Experimental procedure
At first, a solution of OBA (UVITEX BMU-V) is taken and then 3% stock solution is prepared water is added to it. Bath is kept at 60°C temperature and all the chemicals along with the material are added to it.

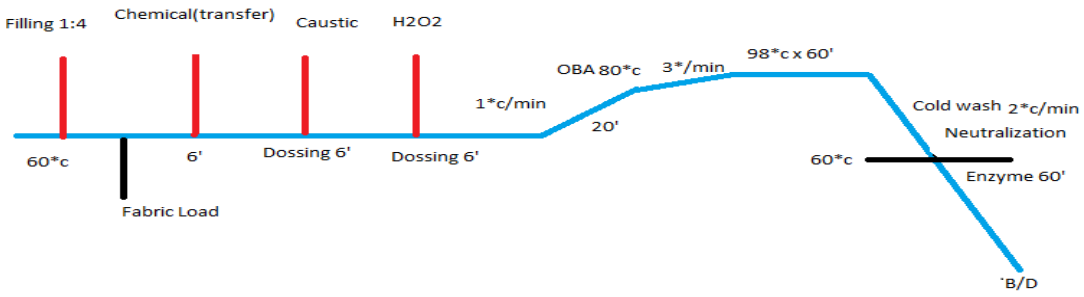

Fig.3.3: Process curve for application of OBA

Then the bath was kept for 15 min without raising the temperature. PH of bath is controlled by caustic soda at 9.5-10.2. Now temperature of dye bath is raised to 90°C and at that temperature the bath is kept for 60 min. Then temperature is lowered to 60°C . Material is cold wash and neutralized at 60°C .

3.5.1 Cationization of cotton fabric

a. Cotton samples were treated with aqueous solution of (Alquat-CF) at L.R= 1:40 with different concentrations (5g/L, 10g/L & 15g/L).
b. pH values kept at (4-8).
c. The process was done at 60°C & 80°C for the duration 30 min.
d. The treated samples were rinsed with cold water, squeezed and then air- dried.

3.5.2 Green technology of whitening

a. The taken weight of the fabric was 7.5g.
b. The liquor ratio was 1:20.
c. From six samples three samples were cationic pretreated.
d. At first all the six samples were treated with 3gm/L baking soda at 40^0 C for 15 minutes.
e. Then the pretreated fabric was soaked in various solution for 3 hours.
f. Three types of solution were used. Those were- lemon juice, vinegar and mixture of lemon juice and vinegar.

3.5.3 Lemon juice

a. Took two samples one was cationic pretreated and another was non-cationized cotton fabric.
b. Amount of lemon juice was taken 3%.
c. Then sample was soaked in prepared lemon juice solution for 3 hours.
d. The treated samples were rinsed with cold water, squeezed and then air- dried.

3.5.4 Vinegar

a. Took two samples one was cationic pretreated and another was non-cationized cotton fabric.
b. Amount of vinegar was taken 3%.
c. Then sample was soaked in prepared lemon juice solution for 3 hours.
d. The treated samples were rinsed with cold water, squeezed and then air- dried.

3.5.5 Mixture of Lemon Juice and Vinegar

a. Took two samples one was cationic pretreated and another was non-cationized cotton fabric.
b. Amount of lemon juice was taken 1.5% and vinegar was 1.5%.
c. Then sample was soaked in prepared lemon juice solution for 3 hours.
d. The treated samples were rinsed with cold water, squeezed and then air- dried.

3.6 Evaluation of whitening quality

3.6.1 Wash fastness test

Wash fastness testing was carried out in a Gyro-wash (GESTAR International co. Ltd. China) using standard testing procedure ISO 105-C06 in wet processing lab at Department of Textile Engineering, Khulna University of Engineering & Technology (KUET). ISO 105 C06 is the first choice of maximum buyers and this procedure was followed in the work [09].

IV. Results and Discussions

4.1 Influence of OBA% on the wash fastness of cotton knitted fabric.

Table 4.1: Whiteness of the sample for various shade % of OBA in color change gray scale after wash

Sample No.	Shade %	Grey Scale
1	0.5%	2
2	1.0%	3
3	1.5%	3
4	2.0%	3
5	2.5%	3
6	3.0%	2

On this scale, 5 indicates that next to no color was lost, and 1 indicates that most color was lost.

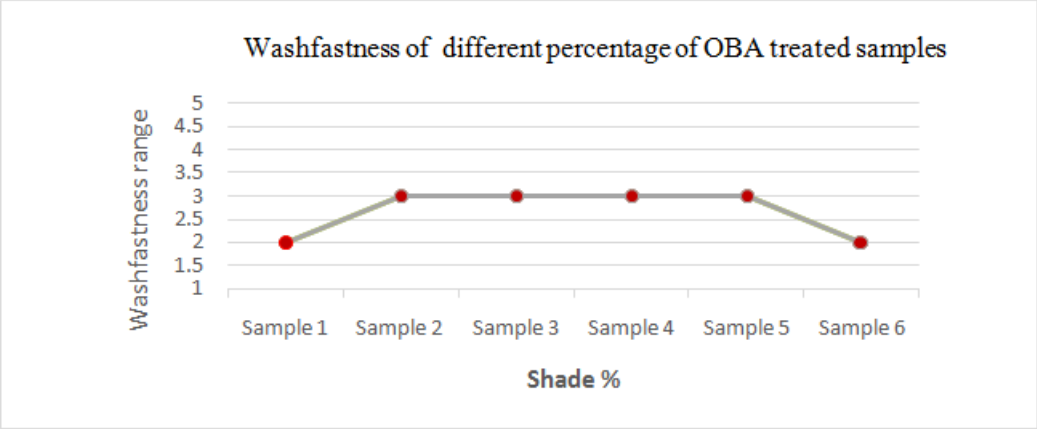

Fig. 4.1: Whiteness of the sample for various shade % of OBA in color change gray scale after wash

From the graph it was found thatwash fastness increases upto certain point when shade percentage of OBA increases but its remains constant for other four shade percentages (1%-2.5%)of OBA. One thing was noticeable for 3% OBA treated fabric that its wash fastness markedly declined to 2. It can be concluded that wash fastness of OBA treated fabric remains not only stable but also decreases in spite of increasing the percentage of OBA. So there is no need to use more amount of OBA for getting better result of wash fastness.

4.2 Influence of Cationizer on the wash fastness of cotton knitted fabric.

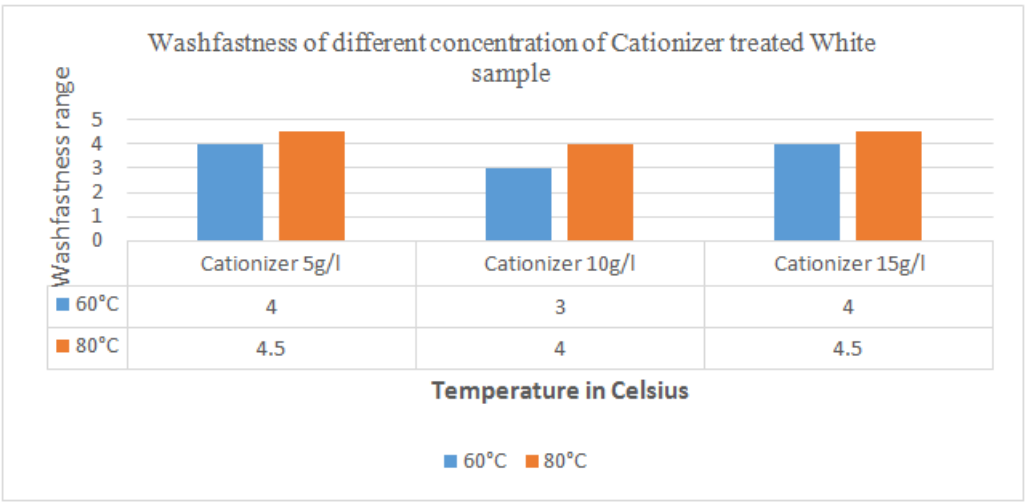

Fig. 4.2: Whiteness of the sample for different concentration of cationizer in color change gray scale after wash

In order to get better wash fastness result of 3% OBA treated fabric our one of the experimental investigation was to carry out the cationization process of the cotton fabric. At the same time we vary the temperature of cationization process for analyzing the effect of temperature on wash fastness result. We use three different concentrations of cationizing agent : 5g/L, 10g/L & 15 g/L and Cationization process was done at 60°C &80°C.After analyzing the result of wash fastness it was found that processing temperature 80°C was more convenient than 60°C. Another fact was clear that we got better result (between 3 to 4.5) due to cationization process at both temperatures. We did not get mentionable variation due to increasing concentrations of cationizing agent. We found that the result of wash fastness was lower at 10g/L of cationizer than 5g/L or 15g/L. So it can be said that concentration of cationizing agent have negligible influence on the washfastness of OBA treated fabric.

4.2 Wash fastness properties of Green OBA treated cotton knitted fabric.

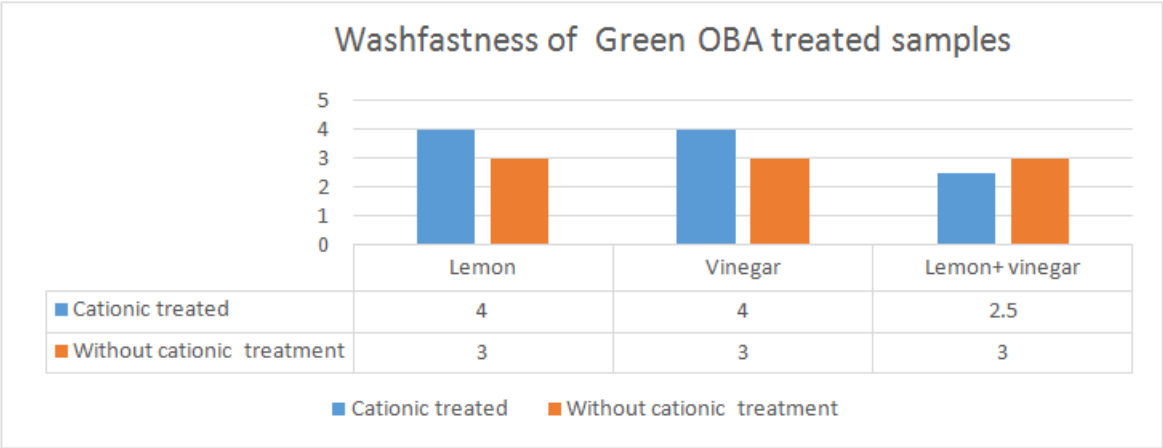

Fig. 4.3: Wash fastness of Green OBA treated fabric for both cationization and without cationization

In this research work our second approach was to get same whitening effect by applying green source of Optical brightening agent of same percentage (3%) such as lemon, vinegar and mixing of both. At the same time we did also cationization process of cotton fabric for green OBA treatment. For Green OBA treated fabric .brightening effect was found same for lemon and vinegar. Moreover these result were higher for cationized fabric as like as synthetic OBA treated cationized fabric .But we did not notice any improvement of wash fastness result due to cationization for mixing of both green OBA. Besides there was no unevenness problem in this process.

4.4 Visual Assessment:

4.4 .1 Shade variation of various percentage of Synthetic OBA treated samples

Figure 4.4: .5% OBA treated Sample

Figure 4.5: 1% OBA treated Sample

Figure 4.6: 1.5% OBA treated Sample

Figure 4.7: 2% OBA treated Sample

Figure 4.8: 2.5% OBA treated Sample

Figure 4.9: 3% OBA treated Sample

Some spots were found of samples before wash. After wash the brightening effect was good. For sample 4 (2% Shade) it was noticed that sample became light from dark shade. It could be said that the shade variation is minimal without any deviation.

4.4.2 Shade variation of treated samples at different concentrated cationizer

Figure 4.10: Cationizer 5g/l (60°C)

Figure 4.11: Cationizer 5g/l (80°C)

Figure 4.12: Cationizer 10g/l (60°C)

Figure 4.13: Cationizer 10g/l (80°C)

Figure 4.14: Cationizer 15g/l (60°C)

Figure 4.15: Cationizer 15g/l (80°C)

From the visual assessment it was observed that cationic agent treated samples show better evenness along with their wash fastness properties compared with sample OBA treated samples .

4.4.3 Whiteness of the samples for different green alternatives:

Figure 4.16: Cationized Sample (lemon)

Figure 4.17: Uncationized Sample (lemon)

Figure 4.18: Cationized Sample (Vinegar)

Figure 4.17: Uncationized Sample (Vinegar)

Figure 4.20: Cationized Sample (Mixed)

Figure4.21:Uncationized Sample (Mixed)

Comparing with other two approaches we got little shade variation for green alternatives although their wash fastness was compatible with them. The brightening effect under D65 showed by the samples was less brighter than normal OBA treated and Cationized treated samples but under UV light it was distinct.

Figure 4.22: Cationized sample under D65

Figure 4.23: Green OBA(lemon) under UV

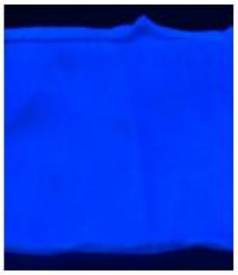

Figure 4.24: Green OBA(Vinegar) under UV

4.25: Green vs synthetic OBA treated samples under UV

One of the remarkable finding of our thesis work was that the brightening effect of green alternatives treated fabrics clearly ahead from other two types of treatment . Our experimental analysis was not only involved to compare with other processes. When we compared the brightening effect among lemon, vinegar and mixed we observed that lemon treated fabric was about 20% darker and brighter than vinegar treated fabric. However, mixed combination of lemon and vinegar did not show mentionable brightness under UV light as well as wash fastness values.

V. Conclusion

In this study we have successfully investigated the possibility of increase the wash fastness values of optical brightening agent (OBA) treated cotton fabric by cationization and using green Optical brightening agent .By varying thesynthetic OBA percentage we tried to analyze the influence of OBA concentration on the wash fastness values and it was observed that wash fastness values initially increases at .5% OBA butit remains stable at 3 from 1% to 2.5% OBA .We did not get desirable result when increase the percentage of OBA from 2.5 to 3 ,its wash fastness values plummeted to 2 . So it can be said that OBA concentration has not noticeable effect on wash fastness values of treated fabric.It would be more suitable decision to keep OBA% at minimal level to get required shade. But in case of cationic pretreatment wash fastness does not depend on concentration of cationic agent:5g/L, 10g/L & 15 g/L because we got almost same result for three different concentrations. However wash fastness value directly depends on the temperature of cationic pretreatment. We observed the wash fastness values were 4.5, 4& 4.5 for 80°C that higher of cationic pretreatment temperature 60°C. Moreover minimal unevenness was found for cationic pretreated cotton whitefabric. In this work our third approach was to use green source as alternatives of synthetic Optical brightening agent(OBA) .For green OBA treated fabric ,We found washfastness values as like synthetic OBA treated samples such as 3,3&3 for lemon, vinegar and mixed combination respectively. We also got better result of wash fastness 4 for lemon and vinegar when it was treated with cationic agent.Considering some health hazardous properties of synthetic Optical brightening agent (OBA) and in order to increase the wash fastness value of OBA treated fabric we applied green resource.Though it was suitable for small scale production but a further research can open the door for green optical brightening agent usages in high scale production.

Acknowledgements

We are grateful to Rupa Knitwear (Pvt) Ltd. for providing cotton fabric and Beximco Knitting Ltd. for technical support for this project work.

References

[1]. Mr. Anwer Tiki, Afreen Amin and Azeema Kanwal, "Chemistry of optical brighteners and uses in textile industries",AVM Chemical Industries, July 2010.
[2]. https://cornfreelifestyle.wordpress.com/2012/02/13/laundry-detergent-and-optical-brighteners/
[3]. Dr Naresh M. Saraf and Deepak V. Alat, "Yellowing of White Fabrics and Garments",of Sarex Overseas, India, August 2006
[4]. http://www.intek.com/Blog/ID/56/What-Is-Catonization.
[5]. http://goatmilkstuff.com/Optical-Brightener.html.
[6]. http://textilelearner.blogspot.com/2011/05/description-of-optical- brightening_4142.html
[7]. http://www.apartmenttherapy.com/how-to-whiten-laundry-without-chlorine-bleach- 109590.
[8]. https://en.wikipedia.org/wiki/Optical_brightener.
[9]. ISO Test Method-105 -C06 C2S, 1994. Color fastness to wash.