Studying standard test methods of color fastness to Washing and Crocking of dyed Cotton/Bamboo Blended fabrics with reactive dyes

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Abstract:

The main object of this study is the comparison between the standard test methods (AATCC - ISO) for color fastness to washing and crocking for Cotton/ Bamboo blended fabrics dyed with different categories of reactive dyes. The standard test methods for color fastness of washing and rubbing were both taken into consideration in order to preserve the difference in results according to the normal test technique processes. The comparison between those two standards leads to the possibility of applying any of them in any test application. Otherwise, when using ISO standard in color fastness to crocking. Can we use AATCC evaluation standard to obtain the results of this test? From the results of color fastness properties for laundering using two standard test methods (ISO & AATCC), it can be observed that according to some differences between the procedures steps of both standard, such as: Number of still balls, amount of detergent, temperature …. etc., some minimal differences were appeared in the results of c.f. to washing; not to exceed 0.5 degree. Concerning results of c.f.to Crocking of dyed samples showed also little difference that depend on the amount of reactive dye which remain on the surface of Cotton/ Bamboo blended fabric after fixing and washing the samples.

Keywords:

Standard test methods (AATCC - ISO), Color Fastness to washing, Color Fastness to Crocking, Cotton/Bamboo blended fabrics.

ملخص:

أحد المتطلبات المهمة قبل استخدام الأقمشة المصبوغة، لضمان جودة المواد، هو اختبار ثبات اللون.. هناك العديد من أهداف طرق اختبار المنسوجات وهي:أن تساعد نتائج الاختبار في تطوير منتجات جديدة أو عمليات جديدة ، وتضمن شحن المنتج المناسب إلى المستهلك أو العميل وأن المنتج يلبي مواصفات العميل ، لضمان جودة المنتج ، وإجراء البحوث والتطوير. من ناحية أخرى ، يتأثر الاختبار بشكل عام واختبار النسيج على وجه الخصوص بالعديد من العوامل التالية: الفني له تأثير كبير على النتيجة ، كما أن حجم العينة غير المناسب سيعطي نتيجة غير دقيقة ، والظروف الجوية عامل مهم للغاية ، الأدوات المستخدمة لإجراء الاختبارات ، مثل: سرعة الماكينة أو الضغط المطبق ، ستؤثر على النتائج النهائية. أخيرًا، يعد استخدام طريقة الاختبار المناسبة أمرًا ضروريًا لتقليل التباين. نظرًا لاختلاف الطرق المتبعة، فإن النتائج ستكون مختلفة.

تقدم المنظمات الكبيرة مثل AATCC و ISOطرق اختبار قياسية للتأكد من أن المنتج يتمتع بجودة جيدة. يهدف هذا البحث إلى تحديد الفروق بين نتائج هاتين الطريقتين القياسيتين للاختبار للأقمشة المخلوطة المصبوغة من القطن / البامبو مع الأصباغ النشطة ، لكل من ثبات اللون للغسيل الاحتكاك.
تقارن هذه الدراسة بين طريقة الاختبار القياسية (AATCC - ISO) لثبات اللون لغسل الأقمشة القطنية / البامبو المخلوطة المصبوغة بفئات مختلفة من الأصباغ التفاعلية. تم أخذ كل من طرق الاختبار القياسية لثبات اللون للغسيل الاحتكاك في الاعتبار من أجل الحفاظ على الاختلاف في النتائج وفقًا لعمليات تقنية الاختبار العادية. من نتائج خصائص ثبات اللون للغسيل باستخدام طريقتين اختبار قياسيتين ISO) و(AATCC، يمكن ملاحظة أنه وفقًا لبعض الاختلاف بين خطوات الإجراءات لكلا المعيارين، مثل: عدد الكرات الساكنة، وكمية المنظف، ودرجة الحرارة ووقت الغسيل، ظهر بعض الاختلاف البسيط في نتائج. للغسيل لا تتجاوز ٠,٥ درجة. فيما يتعلق بنتائج ثبات اللون ضد الاحتكاك للعينات المصبوغة، أظهرت أيضًا اختلافًا طفيفًا يعتمد على كمية الصبغة النشطة التي تبقى على سطح نسيج القطن / بامبو المخلوط بعد تثبيت العينات وغسلها. أيضًا وفقًا لتفاعلية المجموعة الوظيفية وتركيزات الصبغة المختلفة

الكلمات المفتاحية:
مقارنة؛ قطن؛ بامبو

Introduction

Cotton / bamboo blended fabrics are produced to obtain the common properties of the two materials. The organic material content of bamboo is generally similar to cotton; the both are cellulosic fibers. [1] It is made up of monomeric glucose units with β - D groups that are connected using β-1,4-glycosidic links, it is a linear polymer. In addition to the strong glycosidase linkages, this polymer features many hydrogen-bonded attachments. Increasing the quantity of hydrogen bonds between molecules. Therefore, the glycoside and hydrogen bonds support the cellulose polymer's stability. [2,3]

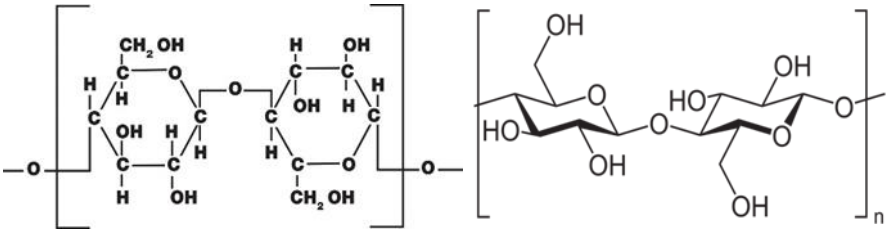


Fig (1): Cotton structure

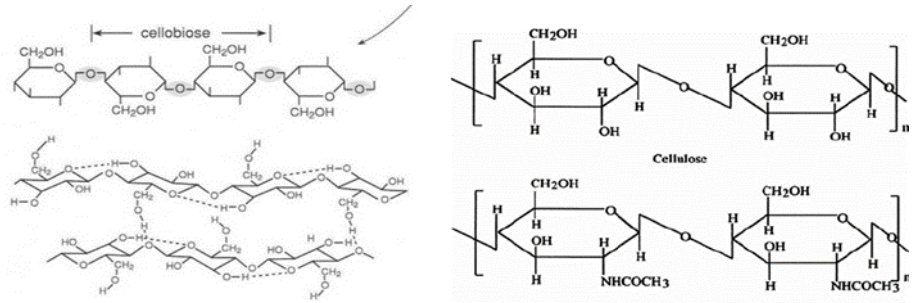


Fig (2) chemical structure of Bamboo

The two most common production processes used to produce textiles, (mechanical methods and chemical procedures), are used in producing bamboo fibers. Bamboo fiber mechanically produced using these steps sequentially: Raw bamboo - bamboo strips - bamboo strip steaming - bamboo strip crushing and decomposition - biological enzyme degumming - fiber carding and natural original bamboo fiber. On the other hand, there are chemical processing phases,

including preparation, steeping, pressing, shredding, ageing, sulfurization, and xanthation. [4] Finally there are some procedures to complete before dyeing cotton or bamboo fibers, including singeing, de-sizing, scouring, bleaching, and mercerizing. [5] Reactive dyes are the only recommended dyeing agent to use for dyeing cotton/bamboo blended fabrics. Reactive dyes provide many benefits, including strong fixation/fastness, availability in a wide range of hues, the ability to make incredibly exact tints, and require no heat. [6,7] Obtaining the common qualities of the two materials enables cotton/bamboo to be blended to produce fabrics that may be used to make towels, mats, blankets, and swimsuits, due to its unique glossiness, soft feel, and good water absorption. Also due to its antibacterial qualities, it is perfect for manufacturing bags for food packaging as well as socks, tights, undergarments, masks, and mattresses. It is a fantastic option for usage in summer clothing due to its UV-blocking qualities, especially to protect young people and pregnant women from UV damage. [8]

One of the important requirements before using a dyed fabric, to ensure the quality of the materials, is the color fastness testing. There are many objectives of textile testing methods which are: testing results aid the development of new products or new processes, ensures the right product is shipped to the consumer or customer and that the product meets the customer specifications, to ensure product quality, and to conduct research and development. [9]

On the other hand, testing in general, and textile testing in particular, is affected by the many following factors: The technician has significant influence on the result, an improper specimen size will also give an inaccurate result, atmospheric conditions are a very important factor, the tools which used to perform tests, such as: the speed of the machine or the pressure applied, will affect the final results. Finally, using of proper test method is necessary to minimize variation. As the methods involved are different, the results will different. [10] Large scale organizations such as AATCC and ISO, present standard test methods to make sure that the product has a good quality. This research aims to determine the differences between the results of those both standard test methods for dyed cotton /bamboo blended fabrics with reactive dyes, for both color fastness to washing and crocking.

Experimental work

Materials

Fabric: Blended cotton/ bamboo fabrics (50% Cotton, 50% Bamboo warp: cotton 40/1 – weft: Bamboo 30/1) were used in this study, which produced by Olama Tex factory – Egypt

Dyestuff: Reactive Dyes for Dyeing:

Three reactive dyes were used in dyeing cotton / bamboo blended fabrics; Suncion Red H-E7B (monochlorotriazen), Sunfix Blue SSR (bifunctional), and Sunzol Green 6B (vinyl sulfone). presented from EL ROWAD company, Cairo, Egypt.

Other chemicals:

Common salt, Sodium chloride (NaCl), Soda Ash (Sodium carbonate Na_2Co_3) and (sodium hydroxide NaOH), Wetting agent, (wetting agent nonionic surfactant IT1303), Sequestering agent HXA Meta Phosphate, Soap (870), of commercial grade were used.

Dyeing of cotton / bamboo blended fabrics:

1- Preparation for Dyeing:

Scouring for blended samples was held by preparing a stock solution with sodium hydroxide NaOH (2gm/L), Sodium carbonate Na_2CO_3 (1gm/L), Wetting agent (1gm/L), Sequestering agent (1 gm/L) in (950 ml) of distilled water. To clean the materials before dyeing, they were submerged in the scouring solution for 30 minutes at 100°C. Then cold water was used to rinse everything.

2- Dyeing technique:

The exhaust dyeing method was applied by using Infrared dyeing machine (STARLET DL-6000).The dyeing baths were prepared using three reactive dyes [Red, Blue and Green] with different concentrations from every dye (1%, 3%, 5%gm/L) using liquor ratio of (1:50). The temperature was adjusted at 40^{o} C , then, cotton / bamboo blended fabrics were immersed in the dyeing bath. The dyeing process was started, then the temperature was raised from 40^{o} C to 60^{o} C in 40 minutes , then common salt (30 gm/L) was added during this period across 3 times every 10 min. Then sodium carbonate (1gm/L) and sodium hydroxide (1gm/L) were added across 30-45min. (As shown in fig.3) as a final step, the samples were rinsed in both hot and cold water then washed with the soap.

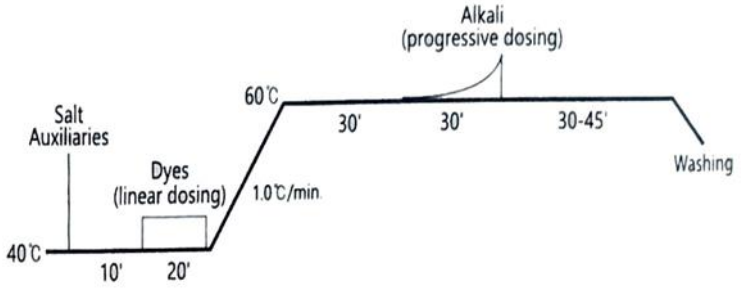


Fig. (3) Reactive dyeing curve

3- Washing step :

Soaping solution was prepared with glycerin (2 gm/L), at liquor ratio (1:20). First immerse the sample of cotton / bamboo at 20ºC for 5 min then raise the temperature to 100ºC for 10 min., then the samples were dried at room temp. fig. (4).

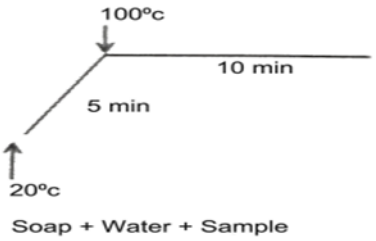


Fig. (4) Washing curve

Color fastness measurements :

After Dyeing of Cotton/Bamboo blended fabrics; the color fastness to laundering and crocking were measured using the two standard test methods (ISO, AATCC) to study the differences between the results of the two standard test methods .

1- Test methods of Color fastness to Laundering:

Laundering fastness refers to a fiber's ability to resist losing color when washed with soap and detergent. The test evaluates how the fabric's color changes as well as how the color of the adjacent cloth is stained. **(11)**

1-1-According to (ISO 105-C06 2010) :

The (ISO 105--C06 2010) test technique was used to determine the color fastness to washing. The washing fastness tests were carried out using the specimen measuring (100±2) mm x (40 ±2) mm sewn to adjacent fabrics, and (25) steel balls. Dissolving 4g/L ordinary detergent (WOB), the liquor ratio is (1: 50 ml) at 50°C for 30 min in a laundero- metre (Rotawash. Model M228CC, SDL Atlas). The specimen was rinsed under running water, squeezed, and dried in the air at a temperature not higher than 60 °C. The grey scale was used to determine change of color and color staining on adjacent fabrics. **(12)**

1-2- According to (AATCC61-2A 2013):

The color fastness to washing was evaluated using the (AATCC61-2013) test method. The specimen measuring (40± 0.2 mm x 100 ± 0.2 mm) was sewed to adjacent fabrics for the washing fastness test, and (10) steel balls were used. The test was performed by adding (0.56 ml) of the detergent solution at 40°C for 45 minutes in a launder meter (SDL.ATLAS - Model: M228BB). After being pressed and dried at air-circulating oven with a maximum temperature of 71°C, the specimen was rinsed under running water. Then the samples conditioned for 1 hour at 65 ±5% relative humidity and 21±2°C before assessing. The test specimens were evaluated by using the grey scale. **(13)**

2- Test method for Color fastness to Rubbing:

Rubbing test method determines the amount of color transferred from the surface of dyed materials to the other surface by rubbing. White crocking cloth squares, both dry and wet with water are employed.

2-1 According to (ISO 105-X12:2016):

Color fastness to rubbing according to ISO standard was assessed using a Crockmeter-James Heal, UK – Model Crock Master in accordance with the ISO (105-X12:2016) test procedure. Before doing the test, the specimen is measuring (50 mm x 140 mm), then must be Conditioning for at least 4 hours (at 21 $\pm 2^{O}$ C and 65% RH).

- Dry crocking test:

Placing the specimen flat over the finger, rub back and forth 20 times (10 times back and 10 times forth), after removing the crocking cloth (Cotton rubbing cloth, shrink, bleached, without finish, 50 mm squares) it was evaluated for staining of color using the gray scale.

- Wet crocking test:

Weight a square of dry rubbing cloth, then wet weight [65 5% pick up] , and repeat same steps as drying method .**(14)**

2-2- According to (AATCC 8 – 2016):

Crockmeter from China, Model: KMS was used in (AATCC 8 – 2016) test technique and color fastness to rubbing was evaluated. The specimen is measuring not less than (50 mm x 130 mm) and white crocking cloth must be conditioned for at least 4 hours prior to the test. (65% RH, 21 $\pm 2^{o}$ C).

- Dry crocking test:

The specimen was placed flat over the finger, rub back and forth 20 times (10 times back and 10 times forth), after removing the crocking cloth (Cotton rubbing cloth, shrink, bleached, without finish, 50 mm squares) was evaluated for color staining using the gray scale.

- Wet crocking test:

Weight a square of dry rubbing cloth, then wet weight [65 5% pick up], and repeat same steps as drying method. [15]

Results & discussions:

Reactive dyes react chemically with the fibers, in which form strong covalent bond. But different classes of reactive dye do not react in the same manner. In reactive dyeing, though water is the competitor for reaction with the dye, cellulose fiber takes part in the reaction in majority. Because the substantively of reactive dye to the fiber is greater than that to water. All these factors can be affected color fastness properties of dyed samples, especially to washing and crocking. [6,7] The wash fastness rating of reactive dyes is dependent on the type of functional group. [1] Covalent bonds are formed when reactive dyes interact with hydroxyl cellulose groups, frequently through nucleophilic substitution or addition. It would be hoped that these strong connections will result in excellent color fastness. [16, 17] This search has mainly defined the differences of color fastness for dyed cotton / bamboo blended fabrics to rubbing and washing according to ISO and AATCC series .

1-Color fastness to laundering (washing) for dyed cotton/bamboo `fabrics:

Wash fastness is the resistance offered by dyed fibers to retain color when washed by soaps and detergents. In the test, change in color of the textile and also staining of color on the adjacent fabric are assessed.

1.1. Sunfix Reactive Dyes:

Three categories of reactive dyes were used throughout this search; Sunfix Blue SSR (bifunctional MCT/VS), was the first type of reactive dyes applied, reacted with cellulosic fabrics by both substitution and addition processes. The better the probability for its affinity, the more reactive groups made. [6]. The results of color fastness qualities for laundering using two industry-recognized test methods (ISO & AATCC) are shown in figures 5a, 5b, and 5c. The results of c.f. to washing varied slightly , depending on differences in the two standard operating methods, such as the number of still balls, detergent used, temperature, and time of washing. In spite of these differences, and by comparison between the two standards, either in change of color or staining on adjacent fabrics, one can find that the difference is not exceeding 0.5 degree. This already considered as the acceptable limit of uncertainty in the test method.

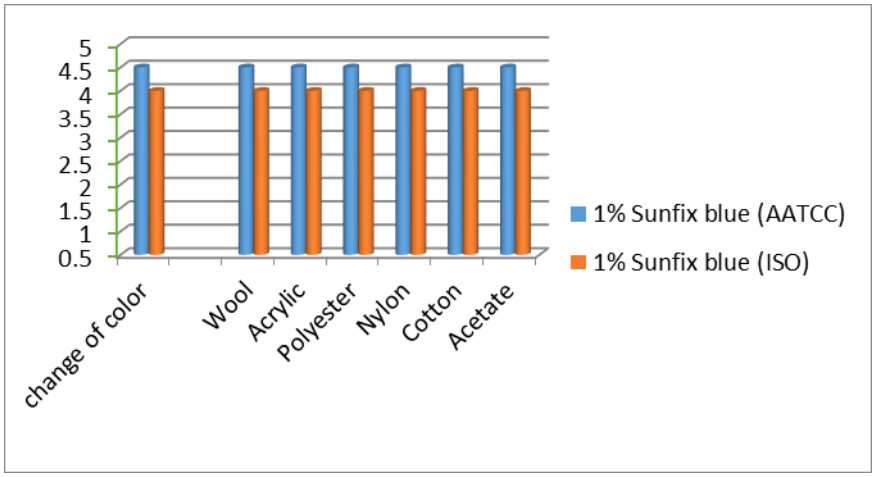


Fig. (5a): 1% Sunfix blue SSR

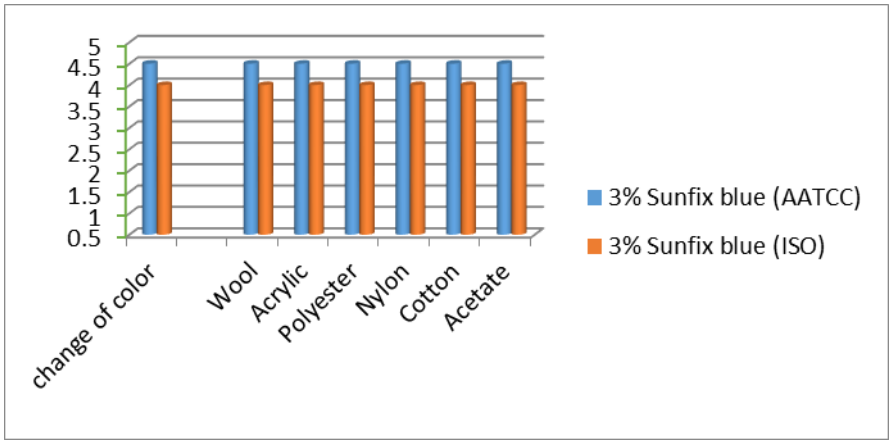


Fig. (5b): 3% Sunfix blue SSR

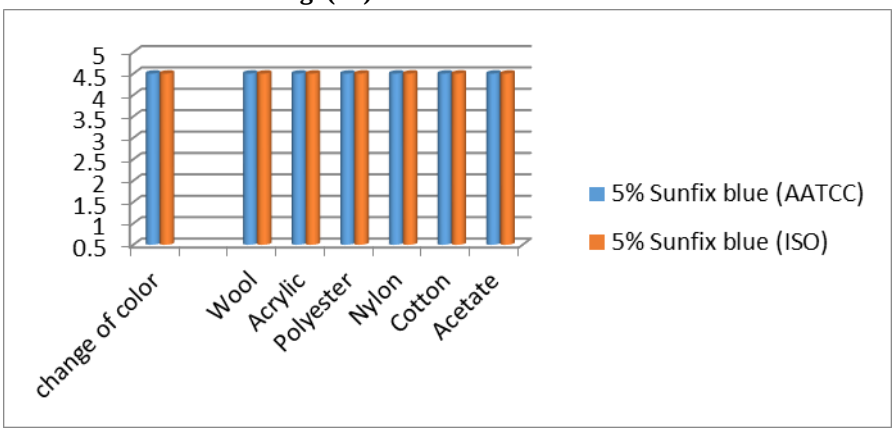


Fig. (5c): 5% Sunfix blue SSR

1.2- Suncion Red H E7B Reactive Dye:

Another type of reactive dyes was used in dyeing cotton / bamboo blended fabrics. Suncion red (monochlorotriazine) , which reacts with the fabric by substitution reaction. Results in fig. (6a, 6b, 6c) show the difference in c.f.to washing, range from 4 to 4.5 degree. This difference represented in all concentrations (1, 3, &5 %) and it might be as a result of the procedures differences as mentioned.

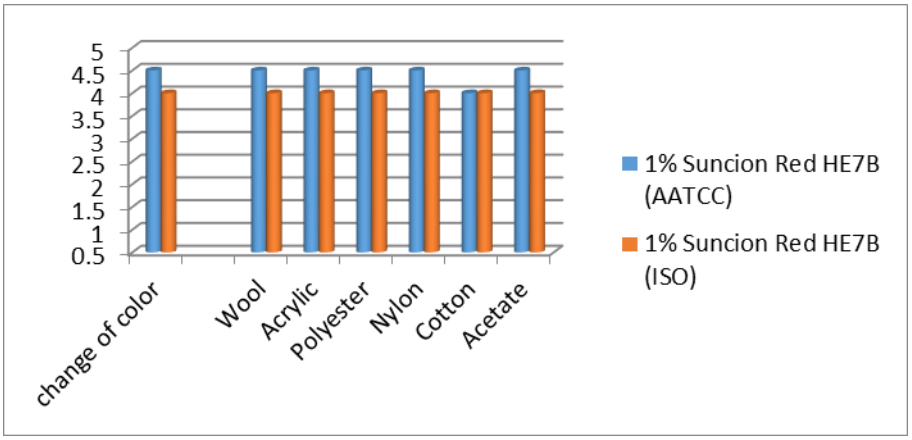


Fig. (6a): 1% Suncuin Red H7B

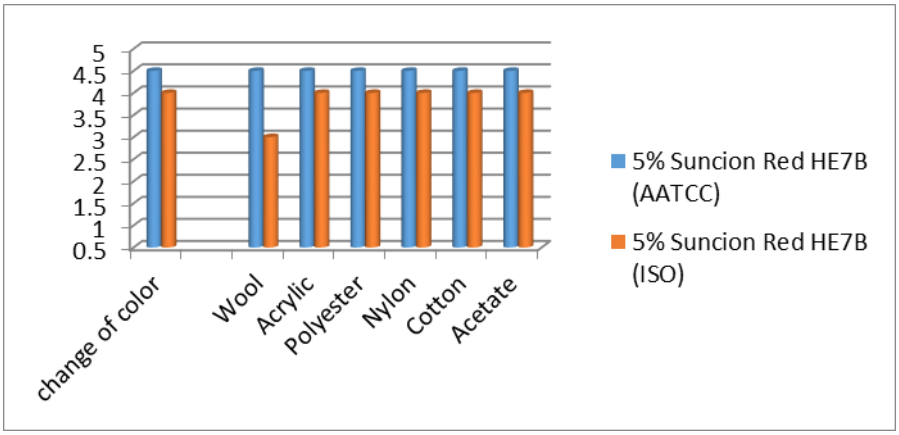
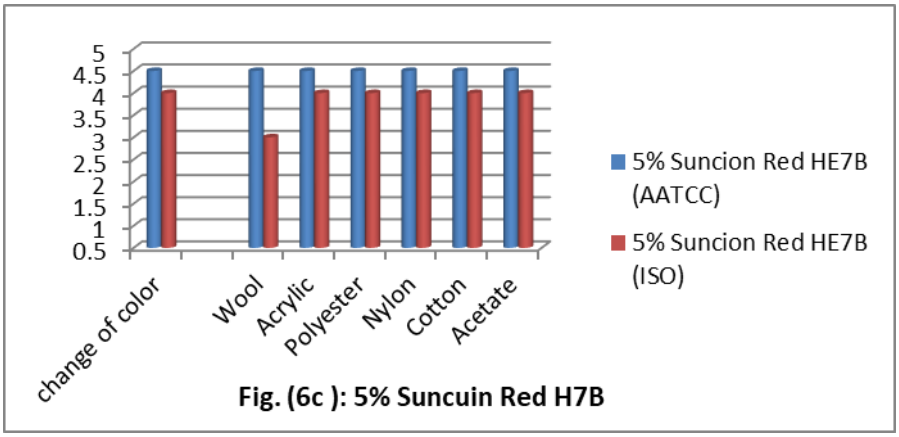


Fig. (6b): 3% Suncuin Red H7B



1.3. Sunzol Green 6B Reactive Dye:

By using the third type of reactive dyes, Sunzol Green 6B (vinyl sulfone), which react with the fabric by addition reaction in dyeing cotton / bamboo blended fabrics. The change of color measuring about 4 degree in both ISO &AATCC results for the three concentrations. It was 0.5-degree difference that was reached between the results in staining on adjacent fabrics. This was observed in all concentrations, as shown in fig. (7a, 7b, 7c).

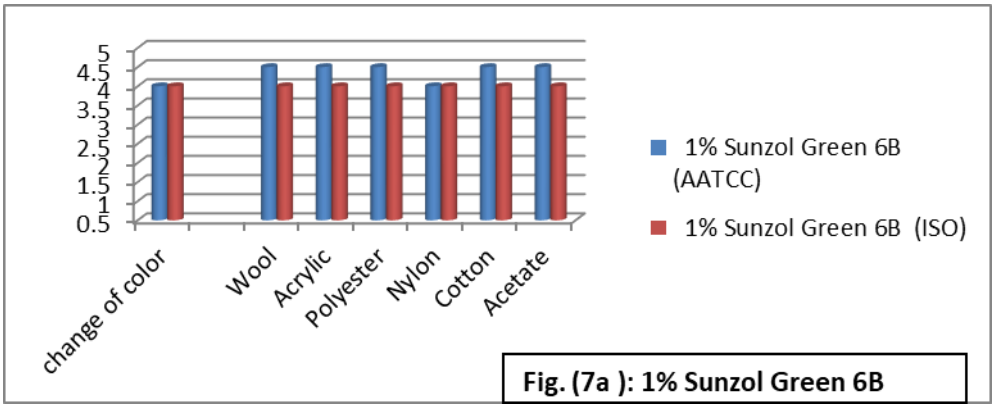


Fig. (7a): 1% Sunzol Green 6B

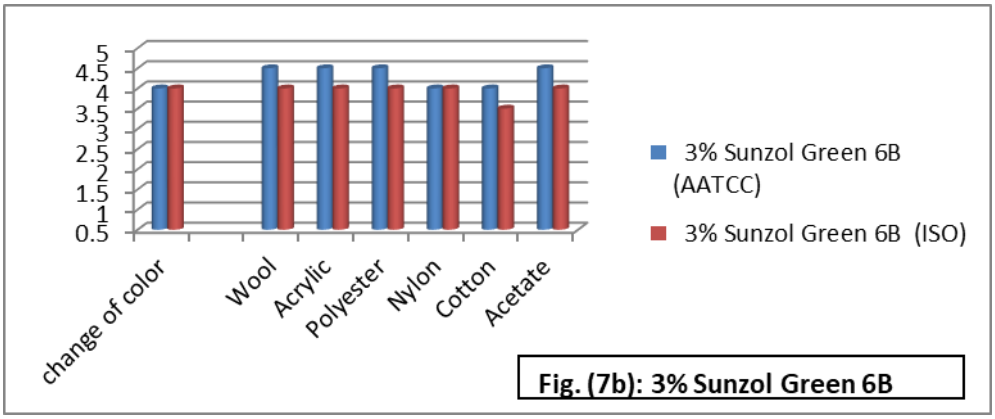


Fig. (7b): 3% Sunzol Green 6B

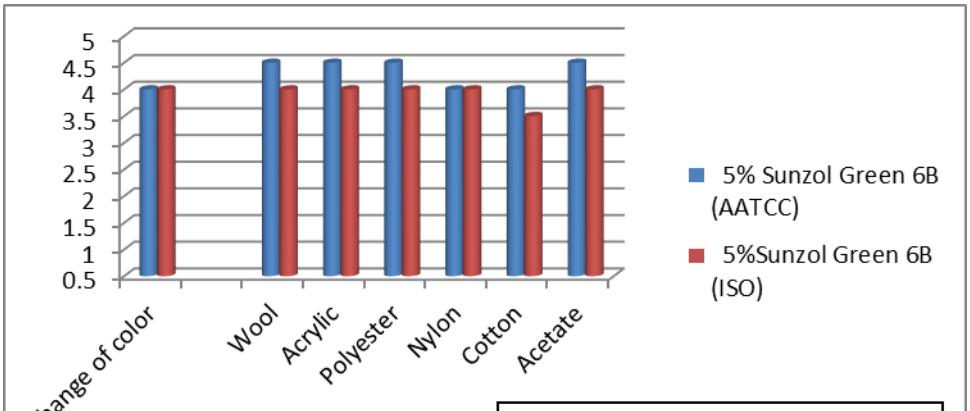


Fig. (7c): 5% Sunzol Green 6B

2-Fastness Properties to Rubbing (Crocking) for Dyed cotton /bamboo blended samples :

The rubbing test was conducted according to Standard test techniques (ISO & AATCC). The purpose of rubbing fastness was to measure how much color may transfer from the surface of a colorful fabric to a predetermined test cloth for rubbing. [18] To evaluate the degree of discoloration of the friction cloth, the textile samples are rubbed with dry and wet friction cloth, respectively. [19] The data show differences between dry and wet crocking tests for the different types of reactive dyes.

2.1-Sunfix Blue SSR Reactive Dyes:

Fig. (8) explains the differences between dry and wet results for crocking using two standard test methods (ISO & AATCC) , which were applied to samples dyed with Sunfix reactive dye (bifunctional) at different concentrations (1,3,5%). Color fastness seemed to be very close in dry samples and not reach more than 0.5 degree in wet ones. These differences between results seemed to be acceptable. [20]

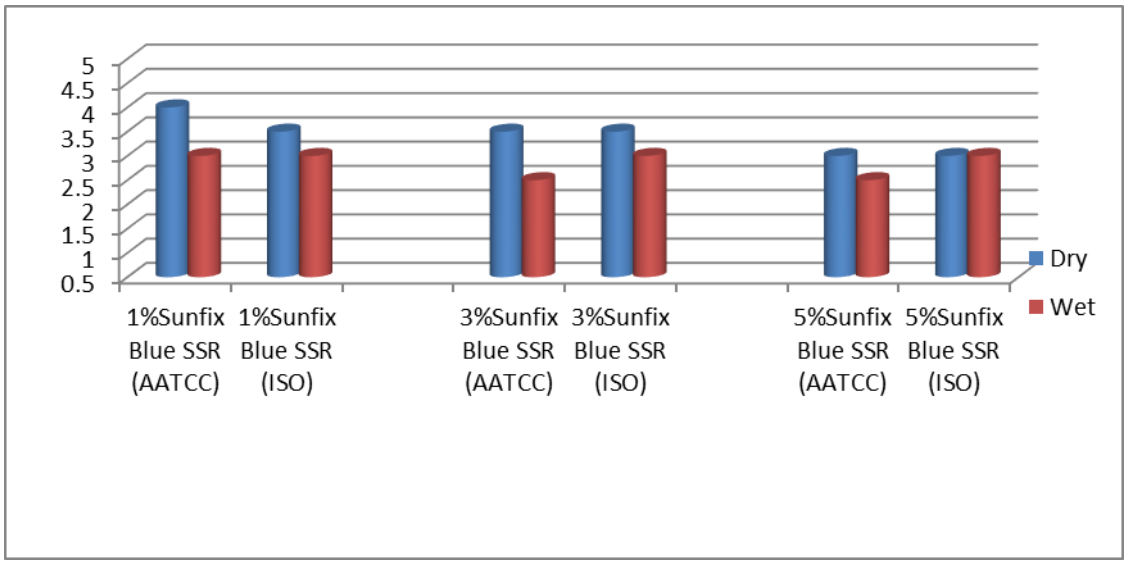


Fig. (8): Crocking Fastness for Sunfix Blue SSR Reactive Dyes

2.1.2- Suncion Red H E7B Reactive Dyes:

2.2- Suncion Red H E7B Reactive Dye:

There were some differences in the results between two standard test methods (ISO & AATCC) for color fastness to Crocking in both dry and wet status. It is clearly noticed from fig. (9) that results have differences that reach one degree between dry tests and 0.5 degree in wet samples for all concentrations (1, 3, 5 %). Concerning rubbing fastness of this dye in both test methods, it seemed to be moderate because of the low reactivity monochlorotriazine functional group.

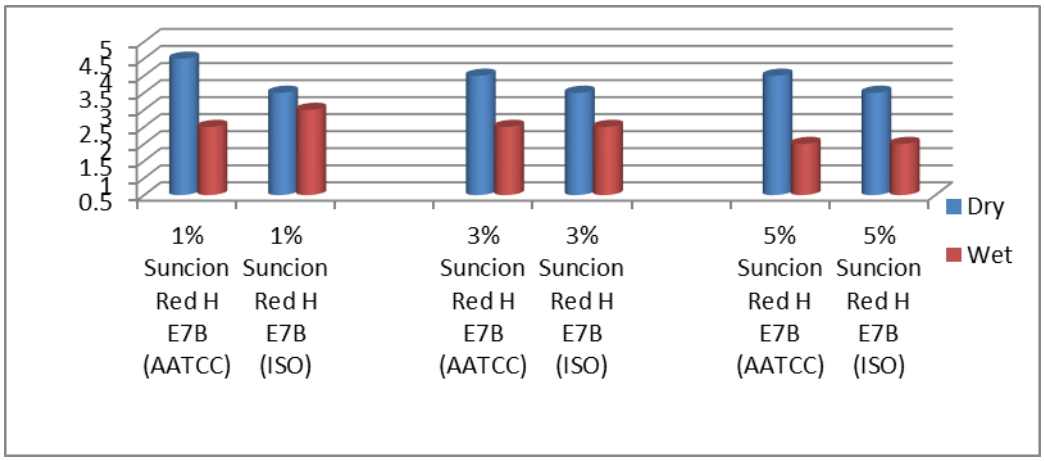


Fig. (9): Crocking Fastness for Suncion Red H E7B Reactive Dyes

2.3- Sunzol Green 6B Reactive Dye:

With this type of Sunzol Green 6B reactive dye, which was used to dye cotton /Bamboo blend fabrics, by addition reaction. Fig. (10) shows the results of C.f.to Crocking (wet & dry) with two commonly used test methods for color fastness (ISO & AATCC). It is clear that when dye concentrations rise, the staining rating rises as well in both test methods. Concerning differences in results, it seemed to be especially in wet tests.

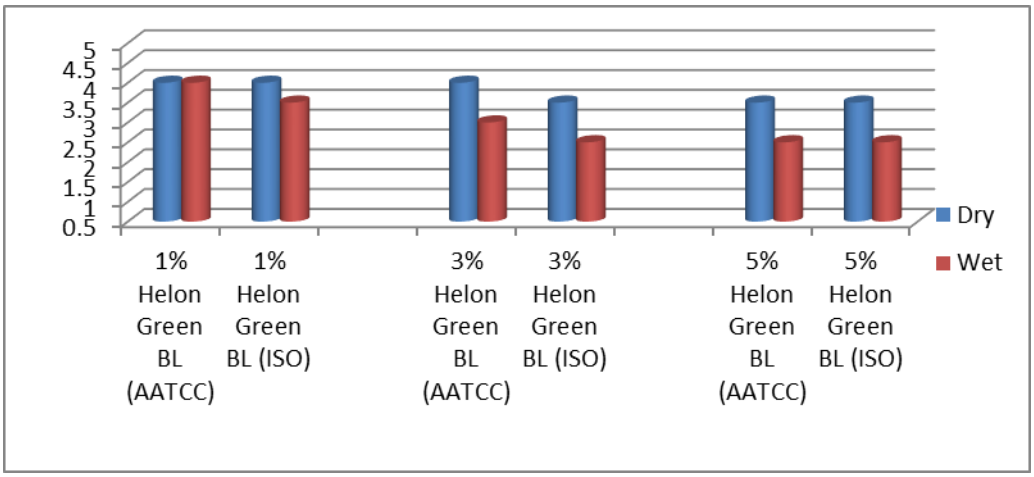


Fig. (10): Crocking Fastness for Sunzol Green 6B Reactive Dye

Conclusion:

Using standard test methods (ISO& AATCC) for color fastness to laundering and crocking for dyed Cotton/ Bamboo blended fabrics with reactive dyes , resulting in some small differences not exceeding one degree on grey scale. Even by using three different types of reactive dyes , differentially react with the fabrics . Those variations may be according to some changes between the procedures of both standards. The amount of reactive dye that remains on the surface of cotton/bamboo blended fabric after fixing and washing, as well as the degree of the dye concentration, are the main factors affecting the grade of color fastness. Approximately , results of color fastness to laundering in both standard test methods (ISO&AATCC) are similar , on the other hand results of color fastness to crocking seems to be different . So in evaluation of the two standard test methods using any of the two methods could be possible in color fastness to laundering, and could be difficult in color fastness to crocking.

References

1. N. I. Mady, Sh. M. Atiha ″ Improving the Fastness and Antimicrobial Properties of Dyed Bamboo and Bamboo/ Cotton Blend with Eco-Friendly Materials ″, Alexandria University, International Design Journal,(2018), Vol. 8, No. 4.

2. S. Gordon and Y-L. Hsieh , ″ Cotton: science and technology ″ University of California, Davis , (2007), pages (3-4).

3. K. Ekman, V. Ekiand, J. Fredrick and O. Tumen, ″ Cellulose structure, Modified and Hydrolysis ″ , Wiley Inter Science, New York, USA, (1986), page 133.

4. Taylor & Francis Group, ″ ISO 9001:2015— A Complete Guide to Quality Management Systems ″, CRC Press is an imprint of Taylor & Francis Group, International Standard Book, (2015), No.-13: 978-1-4987-3321-2.

5. I. Anwar, ″ Bamboo Fabric Dyeing ″, national textile university, Faisalabad, Pakistan, (2011).
6. Haque et al., ″ Compatibility analysis of reactive dyes by exhaustion-fixation and adsorption isotherm on knitted cotton fabric ″, Fashion and Textiles (2015) pages 2-3.
7. N.C. Ghosh et al., ″ study on K/S Value and Fastness Properties of Bi and Poly-Functional Reactive Dyed Cotton Fabrics ″, J. Primeasia Univ,(2018),vol. 2, No.1, pages 34-44.
8. C. Prakash and k. Saravanan, ″ Bamboo fibers & their application in textiles ″, https://www.researchgate.net/publication/259389688
9. M. I. Kiron, ″ Reasons and Importance of Textile Testing ″, textile learner, March 1, (2012), https://textilelearner.net/reasons-and-importance-of-textile-testing/.
10. HU. Jinlian, ″ Fabric Testing ″, The Textile Institute, England, (2008), No. 76.
11. A. Saeed , G. Shabir, ″ Synthesis and characterization of high wash ″, Arabian Journal of chemistry,(2018), edition vol.11,No.1, .
12. INTERNATIONAL STANDARD (ISO 105- C06),(2010) edition Vol.4.
13. AATCC Manual of International Test Methods and Procedures (2021), (AATCC61-2013) 2A, TM61 –(2013)e (2020).
14. INTERNATIONAL STANDARD (ISO 105-X12:2016 (E), (2016) edition vol.6 -.
15. AATCC Technical Manual/2017, TM8-2016, (AATCC 8 - 2016).
16. GW. Madaras, GJ. Parish , J. Shore ″ Batchwise Dyeing of Woven Cellulosic Fabrics: A Practical Guide ″, North Carolina State University. (1993).
17. AD. Wolela , ″ Effect and Role of Salt in Cellulosic Fabric Dyeing ″, Advance Research in Textile Engineering, (2021), edition vol.6, No.1.
18. K. Chaudhary, S. Pant, ″ Comparative Analysis of Color Strength and Color Fastness Properties of Bamboo-Silk and Cotton-Silk Kota Doria Fabrics ″, International Journal of Textile Science (2016), edition vol. 5, No. 2.
19. Z. Lei, ″ Study on Test of Color Fastness to Rubbing of Textiles ″, IOP Conf. Series: Materials Science and Engineering 793, (2020).
20. A. Sakib1, T. Islam1, M. Ahmed1, Md. R. Karim1, Md. R. Hossen, ″ A Comparative Study on Effect of Shade Depth on Various Properties of Cotton Knitted Fabric Dyed with Reactive Dyes ″, International Journal of Clothing Science (2017), edition vol.4, No.1.(12,16).
21. b-Md. Abu Sufian et al., ″ Comparative Study Of Fastness Properties And Color Absorbance Criteria Of Conventional And Avitera Reactive Dyeing On Cotton Knit Fabric ″, European Scientific Journal ,(2016) edition vol.12, No.15.