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Research Article

Impact of Sunlight Exposure to different Dyed fabrics on Colorfastness to Washing

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Abstract

Washing fastness is one of the most desired factors to aesthetic value of cloth. Color of garments can be deformed and changed due to various reasons. This kind of fading or change in the depth of shade leads the users very unsatisfied. Due to this, to study the reason of low washing fastness or color fading is very important. In the present work the effect of sunlight on color fastness to washing rate of different fabrics was studied. Seven different woven and knitted fabrics; 100% cotton, 100% polyester, polyester-cotton, polyester-viscose and polyester-wool blended fabrics were used for this study. Each of the fabric was divided into two groups and colorfastness to washing was done before and after sunlight exposure. In case of fabric exposed to direct sunlight for different set of times, each fabric was tested for washing fastness. The half of those fabrics was directly tested for wash fastness without exposing to direct Sunlight. Both groups of tests were done as per ES ISO 105-C10:2016 standard. This investigation has shown that except polyester-viscose and polyester fabrics, all other samples wash fastness dropped significantly in terms of ratting digital grade as the exposure time has increased.

Keywords: Sunlight exposure; Wash fastness; Fastness Digital Grade; Change in colour; Staining on white; Blended fabrics.

Introduction

Colorfastness is a term used in the dyeing of textile materials or printed fabrics, color change under various conditions. There are various reasons as to which a fabric changes color like sunlight, pollution gases, abrasion perspiration and dry cleaning. A fabric that experiences little color altered when exposed to fading force is said to have a good color fastness. While if the color does not hold, then the fabric has poor colorfastness. There are different types of color fastness such as colorfastness to sunlight, washing, perspiration, crocking, and foresting. Dyed fabrics when exposed to sunlight will in time, fade or change color. This property is called as colorfastness to sunlight. Light fastness testing involves subjecting samples to intense artificial light to assess the impact on the material. Poor performance in light fastness testing indicates that a product is likely to fade when exposed to light. Retailers are also becoming more aware of issues concerning color fastness to light. Higher Color fastness is now being demanded for apparel that will be worn predominantly outdoors. In another way, the resistance to the loss of color of any dyed or printed material to washing is preferred to as its wash fastness. If dye molecules have not penetrated inside the inter polymer a space of fiber or have not attached to the fiber with strong attractive force, poor washing fastness result. Clothing should be tested for colorfastness before giving service, using bleach or other clearing product. The criteria of washing fastness are hence becoming a major concern amongst buyers and consequently with dyers. As described above, Sunlight test and color fastness to washing tests are very differ. But sunlight may have influence on color fastness to washing and other properties of fabrics. Number of researchers [1-7] has studied effect of direct sunlight exposures and fabric properties.

A study was conducted on three-layer goretex fabric with an outer layer of nylon rip stop and an inner layer of nylon tricot fabric. An emulsifiable concentrate was pipetted onto fabric specimens, and the samples were dried for 15

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hours. Sunlight exposure tests and laundry tests were conducted on samples [8]. The effect of sunlight up on color of undyed, chemically unbleached wool fabrics and wool exposed for all periods to Berkeley sunlight through quartz filter a was visibly bleached compared to the unexposed control [9].

A study was conducted on the effect of exposure time on the sorption of pesticide emulsifiable concentrates through microporous fabrics. Ten yards each of acrylic, polyester, and nylon fabrics were used their study. The fabrics were laminated to polyetrafluoethelyene membrane (PTFE), and then the outer fabrics were treated with a water-repellent finish. They have been tested physical properties of the samples [10]. The Effect of Environmental Factors on the Tensile Strength of Kevlar was studied by Rachel McKinnon [11] and the tensile strength was evaluated after a twenty-hour period.

The degradation behavior of polyurethane (PU) coated nylon fabric and woven webbings made of nylon and polyester fibers when exposed to outdoor environment has been studied. The degradation behavior of the samples has been studied in terms of increase in gas permeability (for PU coated nylon fabric only), loss in breaking strength, work of rupture and extension break [12]. Fading on exposure in light is undoubtedly the most complex of the reactions which dyes undergo on a fiber. Energy in the form of light is absorbed by the dye and causes some of its molecules to become unstable and under these conditions, the dye may react with surrounding materials [13].

Cotton fabrics selected for a study involving a desized and scoured print cloth woven to an 80 warp by 80 filling thread count, and a scoured army duck woven to a thread count of 55 warps by 40 filling. The fabrics were specially woven with double warp threads separating the desired number of single threads required for tensile determinations. In addition to the untreated fabrics, three cotton samples representing standard finishing procedures were included in the Chicago studies and were evaluated only breaking strength of the fabrics [14]. During washing fastness test, may be a good result was achieved for once. However, after some time, the rate of poor washing fatness was witnessed. It of interest to us to study this phenomenon, because it may have many reasons for such kinds of behaviour. Theoretically, color fastness to sunlight and washing are independent. Even if it is so, the present work is aimed at studying the effect of exposure to sunlight on color fastness to washing. As it is known, there are many sources of causes for poor color fastness to washing such as selection of dye, dyeing procedure, after treatments, etc. While on usage, sunlight exposure may be one of the reasons to subsequent poor washing fastness.

Materials and Methods

Materials

In this research, 6 different types of fabrics were used for the study. They are 100% cotton, 100% polyester, 65/35% polyester-cotton, 65/40% polyester-cotton, 65/35% polyester-viscose and 60/40% polyester-wool blended fabrics. An open vertically ribbed frame, inclined at an angle of 45°, measuring about 2x2m table was used to place the specimen to expose to direct sunlight [14]. Table 1 provides the details of fibre, blend ratio, fabric structure and dyes used in the fabrics taken for the study. Digieye verivide machine with software version 2.20 was used to measure colors fastness to washing grade.

Preparation of specimens

Each type of fabrics was divided into two groups in order to study color fastness to washing before and after sunlight exposures. One group of fabrics was exposed to direct sunlight on angle of 45° over an inclined table. The samples were exposed during February-April 2016 season because those months are very hot in the Bahir Dar city of Ethiopia where the study was conducted. The exposure time was 8hrs, 24 hrs, 240 hrs, 480 hrs and 960 hrs. The samples were exposed from 10:00 am - 4:00 pm and the weather was 21-25^{0}C & 45-60% RH approximately. Finally both before exposed and after exposed samples were cut to 10×4 cm size prepared to test as per ES ISO 105 C10:2014 standard. Often the most accurate way to test products for light fastness and weather ability is simply to expose them to natural sunlight. Materials can be exposed in a variety of ways, such as under glass to simulate a bright indoor environment, real-time, and outdoor [15].

As shown in figure 1, all samples were cut 10x4cm and washed, dry at room

temperature and finally placed on sample holder to evaluate the grade.

Table 1. Some characteristics of the samples

S. No.	Fabric	Fabric type	Structure	Class of Dye used
1	100% Cotton	Knitted	Plain	Reactive Dye
2	100% Polyester	Woven	Plain	Disperse Dye
3	Polyester-wool (60/40%)	Woven	Twill	Disperse/ Acid Dye
4	Polyester-viscose (65/35%)	Woven	Plain	Disperse/ Reactive Dye
5	Polyester-cotton (65/35%)	Knitted	Plain	Disperse/ Reactive Dye
6	Polyester-cotton (65/40%)	Woven	Twill	Disperse/ Reactive Dye

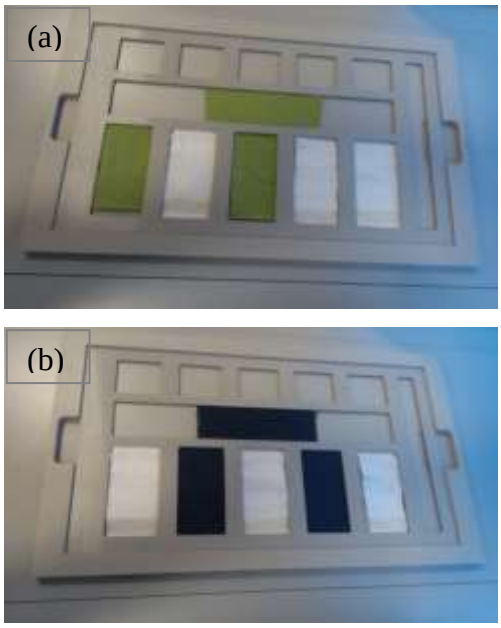

Figure 1. (a) Knitted fabrics (b) woven fabrics

Testing

Determination of color fastness grades by DigiEye digital imaging techniques was used to the study. ES ISO105 C10:2014 standard was used to test the samples [16]. DigiEye is a computer controlled digital camera system for measuring color and capturing high quality repeatable 3D images. It is capable of obtaining reflectance or colorimetric data from within an ultra-small area or a curved surface. In additional to color information, it can also capture the total appearance of an object including gloss and texture details.

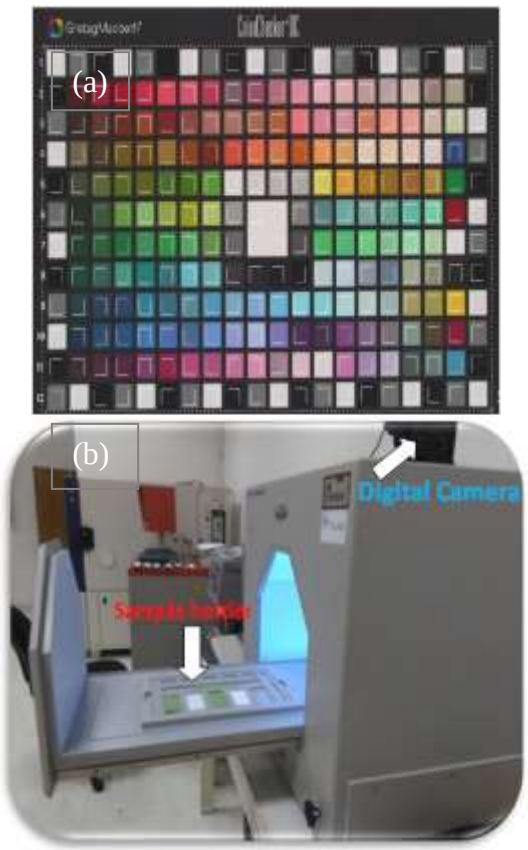

Figure 2. (a) Calibration tile (b) DigiEye vervied machine

This has the advantage over the conventional methods for measuring colors, which only allow taking point color measurements of a flat uniform color samples. After cutting each of samples was washed according to the standard (IS:3361:79) with 5 gpl SDC standard soap, 50^0C, 45 min). The washed samples were dried for 12 hrs at room temperature. Before conducting the test, DigiEye machine was calibrated by its calibration tile so as to get the true delivery value (Figure 2). The dried samples were also conditioned.

The test apparatus consists of a verified digital camera, which is mounted on an illumination cabinet that gives a controlled and consistent lighting environment. Specimens may be presented for grading individually, in multiples, or in one of a series of pre-defined templates depending on the type of test being carried out. To assess the grading manual grey scale and digital grading were used by assessment for either staining or change in color where the system software selects both the location and size of the specimen test area for the reference and tested pieces [17] during testing.

Results and discussion

100% Cotton fabric

The results cotton fabric dyed with Reactive dye (Cold brand), exposed to sunlight for varying time and tested for wash fastness is shown in figure 3. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.578 to 3.439 in 960 hrs of sunlight exposure. However, from 24 hrs to 480 hours of exposure, no significant reduction in wash fastness grade was observed.

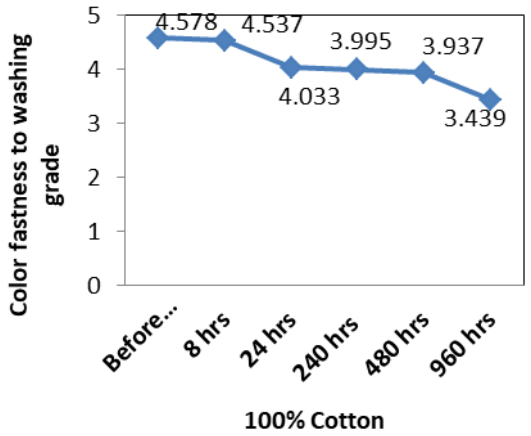

Figure 3. 100% Cotton fabrics color fastness to washing grade

Polyester-cotton (65/35%)

The results P/C blend of 65/35, dyed with disperse and reactive dye, exposed to sunlight for varying time and tested for wash fastness is shown in figure 4. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.1 to 3.64 in 960 hrs of sunlight exposure. However, from 240 hrs to 960 hours of exposure, no reduction in wash fastness grade was observed.

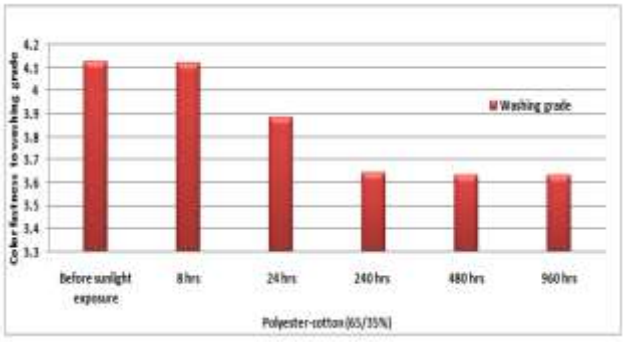

Figure 4. Polyester-Cotton fabrics color fastness to washing digital grade

Polyester-cotton (60/40%)

The results P/C blend of 60/40, dyed with disperse and reactive dye, exposed to sunlight for varying time and tested for wash fastness is shown in figure 5. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.52 to 4.18 in 960 hrs of sunlight exposure. However, from 8 hrs to 24 hrs and from 240 hrs to 480 hrs, it was found to be stable with grade of fastness at 4.39 and 4.29 respectively. From the two types of blends of P/C of 65/35 and 60/40, by comparing the Fig. 4 & 5, one can conclude by saying that the increase in cotton proportion in the blend helps having a stabilized colour fastness grade with exposure to sunlight for varying period.

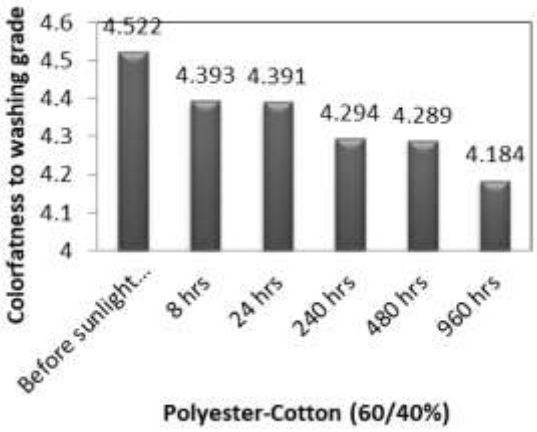

Figure 5. Polyester-Cotton (60/40) fabrics color fastness to washing digital grade

Polyester-Viscose (65/35%)

The results P/V blend of 65/35, dyed with disperse and reactive dye, exposed to sunlight for varying time and tested for wash fastness is shown in figure 6. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.4 to 3.96 in 960 hrs of sunlight exposure. However, from 8 hrs to 480 hours of exposure, no reduction in wash fastness grade was observed. The reduction from 4.4 to 3.9 is also considered to be very negligible and insignificant.

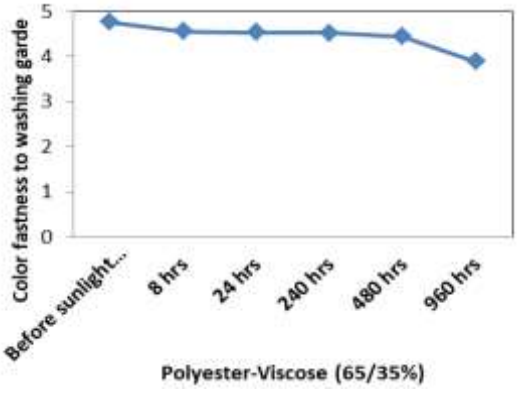

Figure 6. Polyester-Viscose (65/35) fabrics color fastness to washing digital grade

Polyester-wool (60/40%)

The results P/W blend of 60/40, dyed with disperse and acid dye, exposed to sunlight for varying time and tested for wash fastness is shown in figure 7. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.72 to 4.32 in 960 hrs of sunlight exposure. However, from 8 hrs to 240 hrs of exposure, no reduction in wash fastness grade was observed and it remained stable at 4.4.

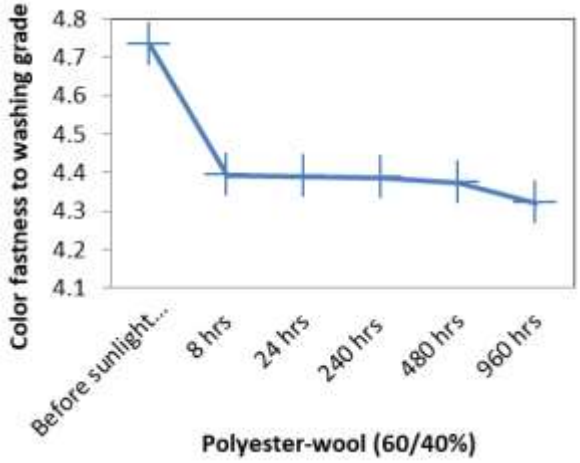

Figure 7. Polyester-Wool (60/40) fabrics color fastness to washing digital grade

100% polyester

The results 100% polyester dyed with disperse dye, exposed to sunlight for varying time and tested for wash fastness is shown in figure 8. From the figure, it is observed that with increasing time of exposure, the wash fastness grade decreased from 4.41 to 4.18 in 960 hrs of sunlight exposure. However, from 8 to 24 hrs and 240 to 960 hrs, it was found to be stable at 4.3 and 4.19 respectively. The reduction from 4.4 to 4.19 is also considered to be very negligible and insignificant.

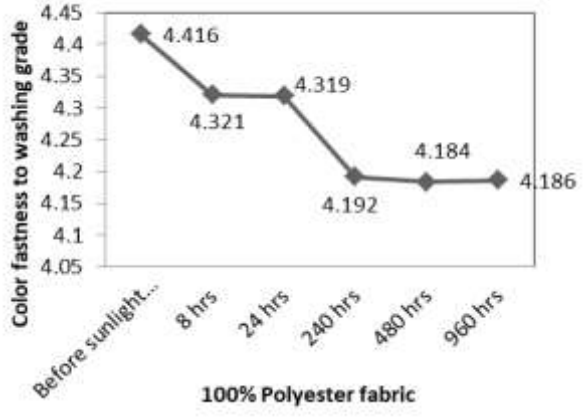

Figure 8. 100% Polyester fabrics color fastness to washing grade

Conclusion

From the study, it may be concluded that by and large all fabrics woven or knitted, irrespective of the type of weave, and dyes used, blend proportions etc; increase in time of exposure to sun light causes reduction in wash fastness grading. In some cases the fastness appeared not changing for quite some period of exposure, though it reduces a bit on subsequent exposure. Very negligible or insignificant reduction in digital grading of wash fastness was observed in case of 100% polyester and 65/35 blend of Polyester/Viscose.

Conflicts of Interest

Authors declare no conflict of interest

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