Effects and Evaluation of Color Fastness of Different Mordants on Knit Fabric Dyed with Onion Outer Skin

MD. MAHBUBUR RAHMAN [1], MD MUTASIM UDDIN[2], FARAH AMREEN[3], SURAIYA IREEN[4], JAGANNATH BISHWAS[5]

[1,2,3,4,5] *Dept. of Textile Engineering, Green University of Bangladesh*

Abstract -- Coloration of fabric is a foremost process in the production of textile material. In this work, at first we collected 100% cotton knit fabric and then natural dye was extracted from onion skin and used to dye cotton fabrics using selected natural and synthetic mordants. The natural mordants were aloe vera, vinegar, lemon and synthetic mordant is acetic acid. Cotton fabrics were dyed using each of the selected mordants under conventional mordanting techniques (post-mordanting), adopting the recognized vat dyeing method. The dyed fabric samples were permitted to age for a day and then washed in standard industrial detergent solution. After dried the fabric, we assess color fastness of this fabric. For assessment of color fastness of this fabric we tested for color fastness to washing, color fastness to light, color fastness to perspiration, color fastness to rubbing. We also tested color strength of this fabric. We got color fastness of this fabric was moderate. We also evaluated the color deviation of this fabric by means of spectrophotometer. It was concluded that onion skin dye with lemon and acetic acid as mordant under post-mordanting technique gave the best result of color fastness of the onion skin dye.

I. INTRODUCTION

Textile materials (natural and synthetic) used to be colored for value addition, look and desire of the customers. Anciently, this purpose of coloring textile was initiated using colors of natural source, until synthetic dyes were invented and commercialized. For ready availability of pure synthetic dyes of different classes and its cost advantages, most of textile dyers manufacturers shifted towards use of synthetic colorant. Almost all the synthetic colorants being synthesized from petrochemical sources through harmful chemical processes pose threat towards its eco-friendliness. Hence, worldwide, rising awareness about organic value of eco-friendly products has generated renewed attention of consumers towards use of textiles (preferably natural fibre product) dyed with eco-friendly natural dyes [1].

Natural dyes are famous for their use in coloring of food substrate, leather as well as natural fibers like wool, silk and cotton as key areas of application since pre-historic times. Onion outer skins are the most commonly discarded domestic and commercial food waste which can be used as dyes for coloring natural textile materials. These dyes, which are known as pelargonidin (3,5,7,4-tetrahydroxyanthocyanidin), work like acid dyes that can dye the cotton fibers at high efficiency . Due to presence of four hydroxy groups (Auxochrome groups) pelargonidin show good dyeing properties for dyeing of natural fibers. However, with the better interest in natural plant dyes a greater significance was given to using mordant. Most of the natural dyes need some sort of mordant to set permanently in any fiber. Natural mordants perform as electron acceptors for electron donors to form coordination bonds with the dye molecules, making them insoluble in water. This leads to develop dye uptake and retention, which result in a enhanced depth of shade and color fastness properties [2].

The current textile processing industry is getting more and more investigation regarding ‘dyeing with natural dyes’ and therefore, the subject of natural colors has assumed a great importance. A growing consciousness, that the intermediates and chemicals used in synthetic dyes are poisonous and unsafe to human health as well as to the surroundings, has led to revival of awareness in the non-toxic eco-friendly coloring materials. The use of natural dyes can be one of the replacement alternatives for many hazardous synthetic dyes [3].

Natural dyes are substantive, requiring a mordant to attach on to the fabric and avoid the colour from either fading with exposure to light or washing out. Mordants attach the natural dyes to the fabric. They also play a great role to produce the resulting shade

faster to light and washing. The shade will be different depending on the mordant used [4].

The skin on the onion with a multiplicity of useful functions as mentioned above was utilized to dye the textile material. This is not only much advantageous to the environmental protection and financial aspect by making use of the disposed skins as waste but also contributable to the improvement of biocompatible fabric materials through more technical framework of the dyeing methods with onion skin color by analyzing the extracts and dyeing the fabric[5].

All natural dyes are eco- friendly and offer a wide range of attractive shades with satisfactory level of color fastness. The demand for natural colors in the modern world is increasing day by day. Global consciousness is also set for the use of natural resources for saving the environment and the earth from contamination and ecological imbalances [6].

Natural dyes have many benefits, such as little toxicity and allergic reactions in addition to bio-degradability because they are taken from animal or plant matter without chemical processing. However, the use of natural dyes declined to a large amount with the advent of synthetic dyes, which have moderate-to-excellent color fastness properties in 1865. During the decade of the 1990s, the textile and apparel industries, mainly the coloration industry, have been extensively criticized for their role in polluting the environment. For these reasons, the use of carcinogenic dyes has been constrained and the use of natural dyes has enhanced [7].

Recently, a great concentration for application of natural dyes is survived for agriculture availability, ease and safe production. Synthetic dyes create varieties of shades which are available in low cost, but cause environmental pollution, so natural dyes are a good substitute for textile coloration. Many researchers studied the functional finishing of textiles materials with natural dyes [8].

The majority of natural dyes require a mordant in the form of a metallic salt to make an affinity between the fiber and the pigment. The only difficulty with the natural dyes is that to achieve a full color range, mordant must be used and whilest the natural dyes are themselves risk-free, the chemicals used for mordanting are generally not environmentally tolerable[9].

At present there is a big “No” to synthetics from the consumers due to the established toxicological effects of some of the synthetic colors. Furthermore natural dyes have an inherent antimicrobial property which is believed to be very effective. Natural dyes extracted from different parts of plants including bark, leaves, roots, fruits or seeds, and flowers have different coloring materials such as tannin, flavonoids and quinonoids. Some natural colors come from microorganisms such as fungi, algae and bacteria. These dyes do not only offer rich and a wide range of colors, but also attain antimicrobial properties, are environmentally friendly and can be used in low-cost treatments with the extra benefit of coloring in a single step [10, 11].

But the troubles associated in dying with natural dyes are inferior extraction of natural colorants and poor fastness. To overcome these problems different metallic salts are being used as mordant, which are traditionally used to develop fastness and produce various shades with the same dye. As a result, natural dyes are among the promising options for increasing a greener textile dyeing process and such interest is reflected to the better number of recent publications [12, 13].

Application of natural dyes has, of course, some restrictions. It is complicated to reproduce shades by using natural dyes. Moreover, these dyes need time-consuming extractions are difficult to apply, and the dyed textile may change color when exposed to the sun, sweat and air. For using natural dyes in an industrial scale, the suitable and standardized extraction processes and dyeing techniques must be developed without sacrificing the required quality and quantity of dyed textiles [14].

Onion (Allium cepa L.) Belongs to the Lilliaceae family and is grown all over the world. After tomatoes, they are the second most horticultural vegetable (Griffiths et al., 2002). Each processing step in onion preparation and processing is characterized by wastes and by-products, with probable impact on the surroundings. The quantity of onion waste produced annually in the European Union is estimated at approximately 450,000 tons. [15].

Recently, dyes and colors of natural origin are gaining worldwide recognition as replacement for synthetic dyes in textile manufacture, for coloring of food products, cosmetics and pharmaceutical products. This renewed interest in the use of natural dyes is primarily due to enhance health concern of many of the synthetic dyes because of their toxic nature and adverse ecological impacts.

II. MATERIALS AND METHODS

1. Materials:

a) Natural Dye Source:

Waste onion skin was collected from local market Mirpur, Dhaka. The onion skin were cleaned and dried, then used to extract the natural dyestuff.

b) Natural and Synthetic Mordants:

Lemon juice, Aloe vera, vinegar were used as natural mordants and acetic acid is used as synthe tic mordant. Fresh lemon, Aloe vera, acetic acid and vinegar was purchased from local market Mirpur, Dhaka. Fresh lemon was squeezed and the juice was collected and filtered. Fresh leaves of Aloe Vera were washed thoroughly, the outer green surface was peeled off and the linear white mass was collected and crushed solid consistency which produces high viscose liquid.

c) Equipment:

- Heat source: We used electric stove for heating the liquid used during mordanting and dyeing.
- Dyeing pans: Stainless steel pans are used for dye extraction.
- Stirring rods: Stainless steel rods were used for stirring.
- Thermometer: Thermometer was used for determination of temperature.
- Measuring Jug
- Storage containers
- Strainer
- Gloves
- Lemon squeezer
- Knife
- Scissor
- Electric balance
- Lab Washing Machine

d) Evaluation of color fastness:

- Color fastness to wash:

Color fastness to wash test was done by a wash fastness tester (Model: MAG-G- C0356) according to ISO 105 C06 A2S method.

- Color fastness to Light:

Color fastness to light test was done by a light fastness tester (Model: Atlas Ci 3000+) according to ISO 105/BO2

- Color fastness to perspiration:

Color fastness to perspiration test was done by a Perspirometer tester according to ISO 105 – EO4 1994 (Acid and Alkaline perspiration)

- Color Fastness to Rubbing:

Color fastness to Rubbing test was done by a Crockmeter according to ISO 105 X 12 2002

- Color Strength K/S:

Color strength value was tested by a spectrophotometer.

III. RESULTS AND DISCUSSIONS

1. Color fastness to washing:

Color fastness to washing is the common quality parameter, which is considered very important from the point of view of consumers. This test determines the loss & change of color in the washing process by a consumer and the possible staining of other garments or lighter portion that may be washed with it. This test is used to predict the performance of any dyed or printed textile product to the common washing process using a detergent and additives.

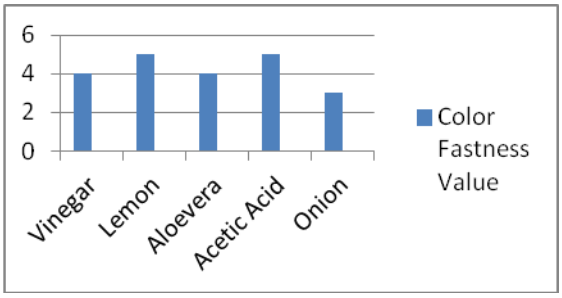
Mordants	Grade					
	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Vinegar	4-5	3-4	4	4	4	4
Lemon	4-5	4	4-5	4-5	4-5	4-5
Aloevera	4-5	4	4-5	4-5	4	4-5
Acetic Acid	4-5	4	4-5	4-5	4-5	4-5
Fresh Onion Dyeing	4-5	4	4-5	4-5	4-5	4-5

2. Color fastness to light:

The purpose of Color fastness to light test is to determine how much the color will fade when exposed to a known light source. It is an off line quality assurance system. Generally man wears the fabric and goes outside of the home for doing their job. In day, sun light fall on the fabric surface. So it needs to know how much protection ability have a fabric to sun light. It is determined by an experiment called color fastness to light. To measure the color fastness a blue scale is used. After completing the test, sample is compared with the blue scale

- Result Table:

Mordants	Light fastness Grade
Vinegar	4
Lemon	5
Aloevera	4
Acetic Acid	5
Fresh Onion	3



3. Color fastness to perspiration:

The garments which come into contact with the body where perspiration is heavy may suffer serious local discoloration. This test is intended to determine the resistance of color of dyed textile to the action of acidic and alkaline perspiration.

- Result Table

Mordant	ISO 105 – E04 Grade	
	Acid solution	Alkaline solution
Vinegar	3-4	3-4
Lemon	4	3-4
Aloevera	3-4	3-4
Acetic Acid	2-3	3
Fresh Onion	4	4

4. Color Fastness to Rubbing:

This test is designed to determine the amount of color transferred from the surface of colored textile material to other surfaces by rubbing.

- Result Table

Mordant	ISO 105 X12 Grade	
	Wet Rubbing	Dry Rubbing
Vinegar	4	4-5
Lemon	4	4-5
Aloevera	4	4-5
Acetic Acid	4	4-5
Fresh Onion	4	4-5

5. Color Strength K/S:

The detailed results for the onion skin dye when applied to cotton fabric samples (photographs of dyed fabrics) using natural mordants and post mordanting techniques are presented in the appendix. The results indicates that there were similar shade of colors obtained after dyeing the cotton fabric samples with onion skin using natural mordants and post mordanting techniques. Natural mordants gave pale yellow colours.

6. Color Strength Values of the Wash-off:

Mordant	Mordanting Method	K/S Values
Vinegar	Post Mordanting	3.80
Lemon	Post Mordanting	4.10
Aloevera	Post Mordanting	3.47
Acetic Acid	Post Mordanting	4.07
Fresh Onion	Post Mordanting	3.18

IV. CONCLUSION

The natural mordants showed significate effect. From the work conducted it was demonstrated that onions skin can be used to successfully dye cotton fabric; it is shown that a color fastness could be derived by using different natural mordants and mordanting techniques. Nonetheless, it was found that as natural mordants lemon if used under post-mordanting technique did produce good results, yielding satisfactory color fastness to the fabric compared to applying the onion skin dye without mordant. They also compared favorably to some of the synthetic mordants considered in this work.

It is therefore obvious that further research should be carried out on natural mordants and their application with natural dyes. A possible trend to investigate is to consider the efficacy of blending the mordants (either natural mordant with natural mordant or natural mordant with synthetic mordant) as some of the mordants from this research work have shown some impressive results under different conditions. So by blending those with other mordants may improve their mordanting properties.

REFERENCES

[1] Abdu Zubairu*, Yusuf Madu Mshelia, "Effects of Selected Mordants on the Application of Natural Dye from Onion Skin (Allium cepa)", Science and Technology 2015, 5(2): 26-32

[2] Mohammad Gias Uddin, "Effects of Different Mordants on Silk Fabric Dyed with Onion Outer Skin Extracts", Hindawi Publishing Corporation, Journal of Textiles, Volume 2014,

[3] GÜLSAH GÜMRÜKÇÜ*, MAHMURE ÜSTÜN ÖZGÜR and CENKKUT GÜLTEKIN†, "Extraction of Anthocyanin Pigments from Red Onion (Alliumcepa L.) And Dyeing Woolen Fabrics", Asian Journal of Chemistry, Vol. 20, No. 4 (2008), 2891-2902.

[4] GÜLSAH GÜMRÜKÇÜ, MAHMURE ÜSTÜN ÖZGÜR*, "Effect of Tannic Acid and Metal Salts on Dyeing of Woolen Fabrics with Red Onion (Alliumcepa L.)", Asian Journal of Chemistry; Vol. 23, No. 4 (2011), 1459-1466.

[5] Bae, Soon-Ei, "A Study of Onion Skin Pigments in the Extracting Solvents and Residual Pigments after Dyeing the Textiles", Journal of Fashion Business, Vol. 13, No. 3, pp.109~117(2009)

[6] Mohammad Raza MIAH1, Felix Y Telegin2, Md. Saifur Rahman[3], "Eco-friendly dyeing of Wool fabric using natural dye extracted from onion's outer shell by using water and organic solvents", International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 09 | Sep-2016.

[7] Mohammad Raza MIAH1, Zakaria2, Md Adnan Hossain3, Atharul Islam Dipto4, Felix Y Telegin 5, Heng Quan[6], "Eco-dyeing of Nylon Fabric Using Natural Dyes Extracted from Onion Outer Shells: Assessment of the Effect of Different Mordant on Color and Fastness Properties", International Journal of Scientific & Engineering Research, Volume 7, Issue 9, September-2016

[8] Gawish SM, Helmy HM*, Ramadan AN, Farouk R and Mashaly HM, "UV Protection Properties of Cotton, Wool, Silk and Nylon Fabrics Dyed with Red Onion Peel, Madder and Chamomile Extracts" Journal of Textile Science & Engineering, Volume 6, Issue 4, 2016.

[9] H T Deo[a] and Roshan Paul, " Dyeing of ecru denim with onion extract as a natural dye using potassium alum in combination with harda and tartaric acid", Indian Journal of Fibre & Textile Research, Vol. 25, pp. 217 – 220, September 2000.

[10] Rasha A. Metwally1*, Amany El Sikaily2, Nermeen A. El-Sersy1, Hanan A. Ghozlan3, Soraya A. Sabry[3], "Antimicrobial activity of textile fabrics dyed with prodigiosin", OAHOST, This journa l is © Open A ccess Hous e of Scien ce and Technolo gy. 2016