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Dyeing Properties of Banana Fibre Dyed with Different Dyes

Tarikul Islam, Md. Rezaul Karim, Mowshumi Roy, Md. Safiqul Islam, Habibullah Mohammad Jayed, Pallab Barua

Abstract: ***The popularity of Sustainable clothing is increasing day by day. Consumers are more interested to consider sustainable clothing design on their daily basis fashion but it is expensive to produce sustainable clothing, as there are less availability of natural fiber. Banana fiber is highly available and it can be a great source of sustainable clothing to meet the consumer demand and banana fiber can be a replacement of cotton fibre. The aim of this project work is to observe the dye ability of banana fiber with synthetic dyes such as vat, acid, basic and reactive dyes were studied. Before dyeing, scouring and bleaching of banana fiber was done and whiteness index was measured. Finally after dyeing, color fastness to wash, color fastness to rubbing was examined.***

Keywords: Banana fiber, Dye ability, Fastness, Sustainable clothing, Synthetic dyes.

I. INTRODUCTION

Banana fiber is a natural bast fiber, which is collected from the pseudostem of banana plant. The banana plant mainly grows in the tropical region such as Bangladesh, India etc. This not only gives us delicious fruit but also gives us fertilizer and fiber. The fibers are abundantly present in all the region of banana plant. After collecting fruit, the pseudostem is thrown away because most of the people in the world are still unfamiliar to the advantageous uses of banana fiber. This fiber has long been met the demand of textile fiber in the world especially in Nepal and Japan [1-2]. The chemical composition of banana fibre is cellulose (50-60)%, hemicelluloses (25-30)%, pectin (3-5)%, lignin (12-18)%, water soluble materials (2-3)% , fat and wax (3-5%) and ash (1-1.5%) [3].The chemical properties of pseudostem of banana fiber is much similar to jute fiber.

With the increasing environmental awareness, banana fibre is recognized as eco-friendly fiber for its good quality and characteristics. In Japan it is used for making traditional dresses like kimono and kamishimo since the edo period. For the lightweight and comfort ability to wear it is used for swimwear and it is also used for curtains, bags, table cloth [4]. For these uses, the banana fiber needs to be extracted and dyed which is extensively studied in this present work .The synthetic dyes are preferable as they provide a wide range of color, being cheap, easier to supply and their fastness properties [5]. Though it has some disadvantages, for the bulk production of banana fiber product, synthetic dyes such as vat, direct, acid, basic dyes are the best option due to its availability in the market.

In this study, the banana fiber was extracted from the stem of banana plant [6] and then dyed with synthetic dyes [7-8]. Finally, the dyed sample was evaluated according to standard testing methods [9-10].

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* Correspondence Author

Tarikul Islam*, Department of Textile Engineering, Jashore University of Science and Technology, Jashore-7408, Bangladesh. E-mail: matarikul.islam2014@gmail.com

Md. Rezaul Karim, Port City International University, Chittagong-4225, Bangladesh. E-mail: rk09006@gmail.com

Mowshumi Roy, Department of Textile Engineering, National Institute of Textile Engineering and Research, Savar, Dhaka-1350, Bangladesh. Email: roymowshum@gmail.com

Md. Safiqul Islam, Department of Textile Engineering, Port City International University, Chittagong, Bangladesh. Email: mdshafiqulislam326@gmail.com

Habibullah Mohammad Jayed, Department of Textile Engineering, Port City International University, Chittagong-4225, Bangladesh. Email: habibjayed.832@gmail.com

Pallab Barua, Department of Textile Engineering, Port City International University, Chittagong-4225, Bangladesh. Email: pallabbarua.net@gmail.com

II. MATERIALS

A. Fiber

Banana tree was collected from local village in Chittagong, Bangladesh and fiber was extracted from the tree by manual method.

Fig. 1. Banana fiber

B. Dyes, Chemicals and Auxiliaries

There are four dyes i.e. reactive, vat dye, acid dye, basic dye were used here. All the dyes used in this study were collected from the laboratory of Port City International University, Chittagong, Bangladesh. Other chemicals such as sodium chloride, sodium hydroxide, hydrogen peroxide, sodium carbonate etc. were collected from local market.

III. METHODS

A. Fiber Extraction

Initially the banana plant sections were cut from the main stem of the plant and then rolled lightly to remove the excess moisture. Impurities in the rolled fibres such as pigments, broken fibres, coating of cellulose etc. were removed manually by means of comb, and then the fibres were cleaned and dried.

Fig. 2. Extracted Banana fiber

B. Scouring and Bleaching

The samples were scoured and bleached to make suitable for the next processes. According to the following recipe banana fiber was pretreated and make ready for dyeing.

Table-I: Recipe of Scouring and Bleaching

Recipe	Amount
Detergent	1gm/L
NaOH	1gm/L
H_2O_2	5gm/L
Soda ash	5gm/L
Wetting agent	1gm/L
Sequestering agent	1gm/L
Time	30 min
Temperature	90 °C
pH	10.5
M:L	1:10

Fig. 3. Grey Samples

Fig. 4. Scoured-bleached Sample

C. Dyeing of Banana Fiber with Various Dyes

In this project work, 1.5% dye concentration was applied on scoured-bleached banana fiber. Then the fibers were dyed by using sample dyeing machine where the liquor ratio was 1:20 for the mentioned dye concentration as the following the recipe of Table 2. The pH of the dye bath was adjusted by soda ash and acetic acid for different dyes. After dyeing, we took the fibre for after treatment. Finally, samples were squeezed and dried.

Table-II: Recipe for dyeing

Types of Dyes →	Direct dyes	Basic dyes	Reactive dyes
Sample weight	5gm	5gm	5gm
Wetting agent	1gm/l	1gm/l	1gm/l
Sequestering agent	1gm/l	1gm/l	1gm/l
Shade %	1.5%	1.5%	1.5%
Glubar Salt	20gm/l	20gm/l	60gm/l
Soda Ash	3 gm/l	-----	15gm/l
Acetic acid	-----	1.5 gm/l	----
Time	40 min	40 min	40min
Temperature	90°C	80 °C	60 °C
pH	7.5	4.5	10.5
M:L	1:20	1:20	1:20

Table-III: Recipe for vat dyeing (Vatting)

Recipe	Amount
Sample weight	5gm
Shade%	1.5%
Hydrose	5 gm/l
Soda ash	5 gm/l
NaOH	3 gm/l
Sequestering agent	1 gm/l
Time	15 min
Temperature	70 °C
pH	11
M:L	1:20

Table-IV: Recipe for vat dyeing (Dyeing)

Recipe	Amount
Salt	15 gm/l
Temperature	70 °C
Time	30 min
M:L	1:20

Table-V: Recipe for vat dyeing (Oxidation)

Recipe	Amount
Acetic acid	1.5 gm/l
H_2O_2	2gm/l
Temperature	80 °C
M:L	1:20

Fig. 5. Dyed Samples

IV. RESULT

A. Assessment of Whiteness Value Scoured-Bleached Samples

Whiteness of grey and pretreated samples was analyzed through measuring the reflectance by using Data-Color software in a spectrophotometer. The experiment was carried out under light source of D65 100 and result shows the satisfactory result as shown in **Figure-6.**

Table-VI: Whiteness Index of Grey samples

SI. No.	Banana fiber sample	Whiteness index	Average whiteness index
1	A	15.38	
2	B	13.16	14.22
3	C	14.50	
4	B	13.87	

Table-VII: Whiteness Index of scoured-bleached samples

SI. No.	Banana fiber sample No.	Whiteness index	Average whiteness index
1	A	59.42	
2	B	61.51	58.88
3	C	54.44	
4	B	60.14	

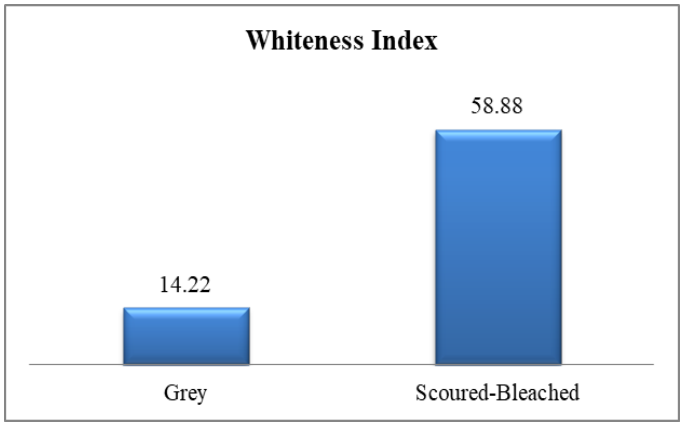

Fig. 6. Whiteness Index of grey and scoured-bleached samples

From **Figure-6,** it is observed that the whiteness of scoured-bleached samples was three times better than grey samples. Due to the removal of natural colorant by the action of bleaching agent make the fibre more light reflective and whiteness of fibre increased rapidly.

B. Assessment of Color Fastness to Wash

Color fastness to wash was assessed for all the samples with multi-fibre fabric by obeying ISO 105 C06 method.

Table-VIII: Change in Color for Wash Fastness

Dyes Used	Change in Color
Direct dyes	3-4
Basic dyes	4
Reactive dyes	4
Vat dyes	4-5

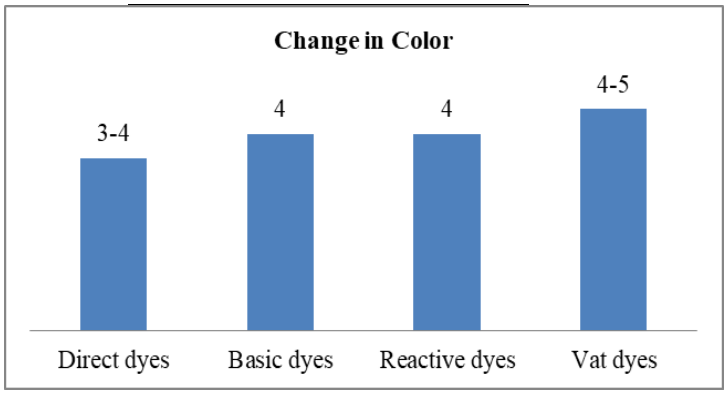

Fig. 7. Change in color due to Wash Fastness

From **Figure-7,** It shows that in the case of color fastness to wash, banana fibre dyed with vat dyes showed better results where the sample dyed with other dyes showed comparatively low but acceptable. However, the sample dyed with direct dyes showed 3-4 ratting.

Table-IX: Color Staining due to Wash Fastness

Multifibre	Direct Dyes	Basic Dyes	Reactive Dyes	Vat Dyes
Acetate	3	3-4	4	4
Cotton	2	3	4	4
Nylon	2	3-4	4-5	4
Polyster	2-3	3	4-5	4-5

Acrylic	2-3	3	4	4
Wool	3	3	4	4

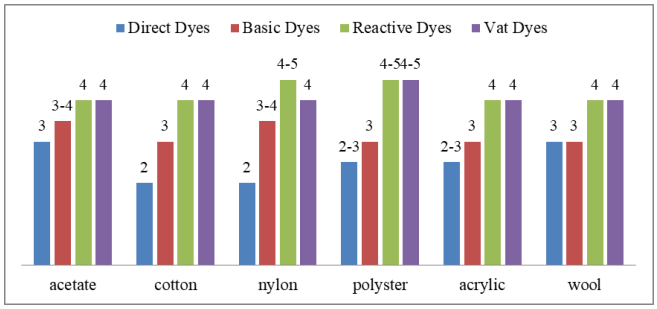

Fig. 8. Color Staining due to Wash Fastness

From **Figure-8**, It shows that in the case of color staining, sample dyed with reactive and vat dyes exhibit excellent results for every multifibre rather than other two dyes.

C. Assessment of Color Fastness to Rubbing

Color fastness to rubbing in this experiment was assessed by obeying ISO 105 x 12 methods. Usually color fastness was assessed separately with respect to fading and staining in the basis of wet & dry phase. The figure shows that the color fastness to wash of banana fibre dyed samples which were graded by the grey scale.

Table-X: Color Fastness to Rubbing

Dyes Used	Dry rubbing	Wet rubbing
Direct Dyes	5	4
Basic Dyes	5	4-5
Reactive Dyes	5	4-5
Vat Dyes	5	4-5

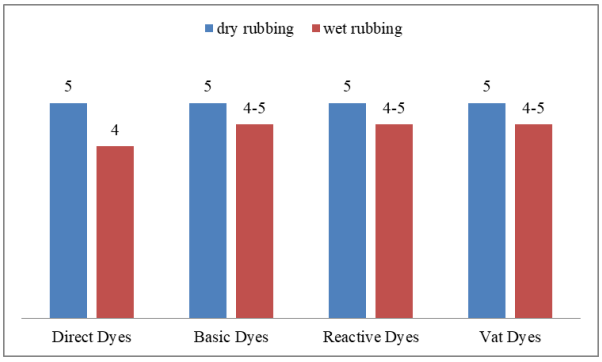

Fig. 9. Assessment of Color Fastness to Rubbing

For color fastness to rubbing almost all of the dyes showed better results in case of dry and wet rubbing (As shown in **Figure-9**).

V. Conclusion

The shade and fastness properties obtained by synthetic dye shows that it is possible to dye banana fiber with synthetic dyes. Color fastness to wash and color fastness to rubbing was very good for every dyes used in this study. However, it has been shown that sample dyed with reactive, vat and basic dyes gave better wash fastness compared to direct dyes. Color fastness to rubbing for the four samples was excellent. From the above discussion, it can be recommended that vat, reactive and basic dyes might be suitable dyes for dyeing banana fibre for bulk production.

Author Contributions

This project work was done under the supervision of M.R.K and T.I. The sample development, experimental design, testing, and the presentation part was done by M.R., M.S.I, P.B., and H.M.J. Finally, all authors revised the manuscript carefully.

Conflict of Interest

The authors have declared no conflicts of interest regarding the publication of this paper.

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10. ISO 105 x 12 standard

AUTHORS PROFILE

Tarikul Islam is currently working as a Lecturer of Department of Textile Engineering, Jashore University of Science and Technology, Jashore-7408, Bangladesh. He has completed his B.Sc. in Textile Engineering from Mawlana Bhashani Science & Technology University, Tangail-1902, Bangladesh. Also, pursuing his M.Sc. in Textile Engineering in Bangladesh University of Textiles, Dhaka, Bangladesh. After completing his graduation, he worked as a Management Trainee Officer at Vertex Group (Nov, 2015-April, 2016). In 2016, he decided to change his passion and joined as Lecturer at Port City International University, Chittagong, Bangladesh (April, 2016- March, 2018) and after that joined as a Lecturer at BGMEA University of Fashion & Technology, Dhaka, Bangladesh in March, 2018. His research interest is Polymer and Composite, Natural Dyes, Biobased Materials, Production Planning & Control, Quality Management etc.

Md. Rezaul Karim has completed his B.Sc. in Textile Engineering degree from Mawlana Bhashani Science and Technology University, Tangail-1902, Bangladesh and assured 1st class 1st position. Now He is working as a Lecturer (Textile Engineering) at Port City International University, Chittagong, Bangladesh and onward M.Sc. in Textile Engineering at Bangladesh University of Textiles, Dhaka, Bangladesh. He started his career as an Executive of Knit Dyeing Production in Impress-Newtex Composite Textiles Ltd., Tangail, Bangladesh from 01 April, 2014 to 31 October, 2016.He also worked at Yarn Dyeing Production. His major research area is Optimization of water utilization in textile processing; Dyeing process development, Eco-friendly dyeing and finishing; Fabric surface modification; Utilization of sea water in wet process.

Mowshumi Roy is working as a Lecturer at Department of Textile Engineering, National Institute of Textile Engineering and Research, Savar, Dhaka-1350, Bangladesh. She has completed his B.Sc. in Textile Engineering from Mawlana Bhashani Science & Technology University, Tangail-1902, Bangladesh. Also, pursuing her M.Sc. in Textile Engineering in Bangladesh University of Textiles, Dhaka, Bangladesh. After completed her graduation, she worked as a SD (Sales and Distribution) Trainee at Viyellatex Group (May, 2013-August, 2013). After that she work as a Merchandising Trainee Officer at Iron Will Macao Commercial Offshore (May, 2014- October 2014) In 2014, she joined as Lecturer at European University of Bangladesh, Dhaka-1216, Bangladesh (October, 2014- March, 2018) and after that joined as a Lecturer at National Institute of Textile Engineering and Research, Savar, Dhaka-1350, Bangladesh in April, 2018. Her research interest is Engineering Manufacturing, Comfortability Analysis of Textile Material, Smart Textile, Biobased Materials, Polymer and Composite, Natural Fibre and Dyes, Production Planning & Control, Quality Management etc.

Md. Safiqul Islam has earned his B.Sc. in Textile Engineering Degree From Port City International University, Chittagong , Bangladesh and assured 1st class 1st Position. now he is working for the Premier 1888 Mills Ltd. at CEPZ, Chittagong, Bangladesh as an Executive officer in Laboratory Department. His working area associated with Textile Testing (Physical & Chemical) and dyeing. He started his career with this company from 15 April 2018 and continuing his job here in Bangladesh with this company. He got training about ISO and AATCC testing method.

Habibullah Mohammad Jayed has completed his B.Sc. in Textile Engineering from Port City International University, Chittagong, Bangladesh and appeared in 1st Class 1st Position. Now he is working as a Senior Executive Officer at the Department of Dyeing Research & Development in Pacific Jeans Group, CEPZ, Chittagong, Bangladesh. After Completing his graduation, He started his career as a Senior Executive Officer, Pacific Jeans Group, CEPZ, Chittagong, Bangladesh from August, 2018 to till now. He also was an Engineering Apprenticeship at Arena Composite & Spinning Industries Ltd., Chittagong, Bangladesh. His major research area is Effect of Salt & Alkali Variation on cotton Fabric Dyeing with Reactive Dyes, Different Dyeing process with different Dyes and development, Natural dyes, Effect of different mordanting agents on the fastness properties of different cotton knitted fabrics.

Pallab Barua currently working in a reputed company, Pacific Jeans Ltd., Chittagong, Bangladesh. He accomplished his B.Sc. in Textile Engineering from Port City International University, Chittagong, Bangladesh. He has a great passion to do something benevolent for textile sector & also has a concern about the negative impact of textile industry to the environment. His research interest mainly in following areas: Natural fibers, Recycled materials, Natural dyes, Polymer science, Material science etc.