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Coloration of Cotton Knit Fabric with Natural Dyes Extracted from *Mikania micrantha* Leaves

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Abstract
The object of this work was to study the influence of dyes extracted from *Mikania micrantha* leaves on 100% cotton bleached knit fabric dyeing. Extraction was carried out using a blending machine and adding a small amount of water during extraction to achieve a suitable density of liquor and allowing the dyes to penetrate easily into the fabric. The dyeing process was done in the exhaust method in a lab dyeing machine, and the shade evaluation, reflectance, color strength k/s values, color fastness to wash and rubbing were measured. The samples show better results after dyeing in terms of shade variation. The color difference DE of all the samples were in from 0 to 2, the highest reflectance percentage was 66.2 at 750 nm, and 17.5 at 360 wavelength was the lowest value, the maximum k/s value was 1.9 at 360 nm, and 0.08 was the lower most value at 750 nm wavelength, the color fastness to wash and rubbing brought very good results with the grey scale rating 4-5. Dyeing and the other tests were carried out at wet processing laboratory at the Department of Textile Engineering in Southeast University.

Keywords: *Mikania micrantha* leaves, Natural dye, Spectrophotometric evaluation, Reflectance, K/S values.

1. Introduction

The utilization of natural dyes bounded chemical groups for example: indigoid, anthraquinone, alpha-hydroxy-napthoquinones, flavones, dihydropyrans, anthocyananidins, carotenoids etc., are for textile coloration is reduced significantly after the discovery of synthetic dyes in 1856, Due to the significant decrease in the cost of synthetic dye stuffs, the natural dyes were virtually unused at the beginning of the twentieth century[1,12].In comparison to the natural dyes, the textile dyeing industry currently uses an excessive number of synthetic dyes to meet the required coloration of global textile consumption due to lower prices, a wider range of bright shades, and significantly improved fastness properties [2]. Recently, there is a surge of curiosioty in dyeing of textiles with a variety of dyes from the natural sources to create decorative effects which involves immersing fabric in a solution of dyes and other auxiliaries [3].

Mikaria micrantha leaf is a natural dye source for green colorant. Natural dyes are mostly environmentally friendly because they are ecological, less toxic, and allergenic than artificial dyes [4]. The coordination bonding of cellulose molecules to natural dyes with the assistance of mordants, cotton fibers can be colored [5]. One of the downsides of mordant use is that the final color cannot be seen until the mordant is added, since mordant salter the color by means of complex formation with natural dyes, and color can't be inverted because coordination bond formation begins after the mordant is added. This scenario affects reproducibility and is unwanted in the dyeing industry [6-7]. Many researchers had done their work on these leaves for anti-microbial properties. Natural product chemists have been intrigued by its antibacterial, anticancer, analgesic,

inflammatory properties etc. [8-11, 13].In this work, cotton knit fabric samples have been dyed with the extract of *Mikania micrantha* leaves without any mordants. Figure 1 shows a photo of *Mikania micrantha* leaves.

Figure 1. *Mikania micrantha* leaves

2. Materials and Methods

For this research, a single jersey scoured and bleached cotton knit fabric (140gsm) was chosen. *Mikania micrantha* leaves were harvested from local area in Bangladesh. To make a liquid solution, the leaves were placed in a blender with a small amount of water.

Table 1. The amount of fabric samples, dyes and chemicals used

Samples	Fabric wt. g	Dye solution mL.	Glauber salt g	Soda ash g
S-1	2.80	28	0.5	0.25
S-2	2.30	23	1.0	0.5
S-3	2.46	24.6	1.5	1.0
S-4	2.60	26	0.52	0.26
S-5	2.50	25	0.5	0.25
S-6	2.3	23	x	x

The solution was used at M:L ratio 1:10and six samples indicated as S-1, S-2, S-3, S-4, S-5 and S-6 in this article. S-1 to S-5 were dyed with the dye solution extracted from *Mikania micrantha* leaves in addition of Glauber's salt ($Na_2SO_4.10H_2O$) at 20g/L and soda ash (Na_2CO_3) at 10g/L respectively and S-6 was dyed without salt and soda. The dyeing was carried out at 60°C for 60 minutes in a lab dyeing machine. Table 1 shows the amount of samples, dye solutions and the chemicals used in this work

2.1 Dye extraction process

To eliminate dust and impurities, the leaves were washed properly with clean water. The leaves were cut into small pieces to make blending easier and converted into a liquid dye solution. The dyeing process was carried out with this extracted solution.

2.2 Evaluation of Color Strength and Fastness Properties

The color iMatch (Version 9.4.10) of spectrophotometer (X-Rite) was used as the color measuring equipment for spectrophotometric evaluation. By measuring the reflectance percentages, color strength k/s values, DL and DE of the samples were evaluated.

2.3 Color fastness to wash and Rubbing

Color fastness to wash and rubbing were determined by ISO 105-C06 and ISO 105-X12 methods respectively.

3. Results and Discussions

3.1 Shade evaluation

Table 2 shows the shades of the samples which were compared in color matching cabinet under D65 light source.

Table-2. Shade comparison of *Mikania micrantha* dyed samples

S-1	S-2	S-3	S-4	S-5	S-6

3.2 Evaluation of Reflectance %

Figure 1 reveals that the reflectance percentage 66.2 is found for S-5 at 750 nm wavelength which is highest value whereas 17.5 reflectance percentages found forS-6 at 360 wavelengths which was lowest. However, for S-1 the lowest value was found 17.8 at 360 nm wavelength while highest reflectance percentage value 63.9 is found at 750 wavelengths.

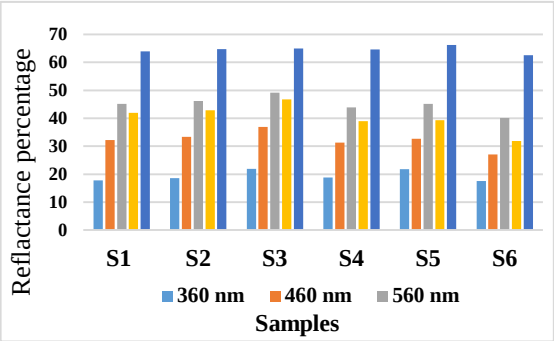

Figure1. The comparison of reflectance percentage among the dyed samples in different wave length.

The lowest values are found for S-2, S-3, S-4,S-5 are at 360 nm wavelength which are 18.6, 21.9, 18.8, 21.8, 17.5 respectively and the highest values are found at 750nm wavelength that are 64.7, 64.9, 64.6, 66.2 and 62.6 respectively. The values are increased approximately double for all the samples from 360 to 460nm wavelengths. The values are slightly decreased for samplesS-1, S-2,S-3,S-4,S-5 andS-6 from 560 to 660nm wavelength. The reflectance percentages reveal that the cotton fabric samples have been dyed and reflectance percentages were found in visual spectrum from 360-750 nm wave lengths [14-15].

3.3 Evaluation of color strength

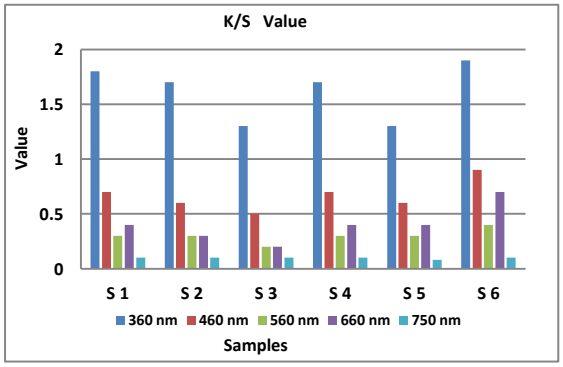

Figure 2. The comparison of color strength k/s values among dyed samples.

From figure 2, it is observed that the highest k/s value is 1.9 found in samples 6 at 360 nm wavelength followed by the second top value is similar for sample S-2 & S-4 which is 1.7. The third top value is 1.3 for sample S-3 & S-5 at the same wavelength. On the other hand, the k/s value 0.08 is found in sample S-5 at 750 nm wavelength which is the lowest value whereas the second lowest value 0.1 is found for samples S-1, S-2, S-3, S-4, & S-6 at the same wavelength. At wavelength 460 nm& 660 nm, the deviation among all the samples is 0.1 except S-6. Moreover, highest k/s value found in S-6 at 360 nm wavelength and the lowest k/s value found in S-5 at 750 nm wavelength [14-15].

3.4 Evaluation of shades

Here the DL, DEcolour matching committee (CMC) values graph with the light sources also elucidated.

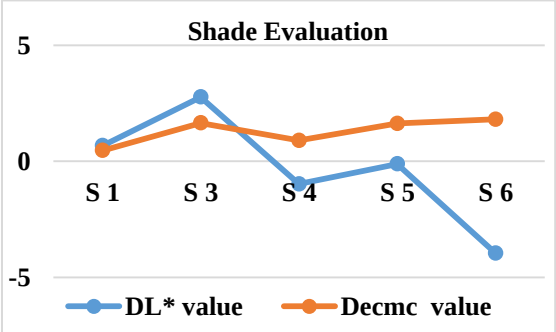

Figure 3. The comparison of shade among dyed samples in line diagrams

The standard sample was chosen as S-2. As compared to S-2, the S-1 and S-3 were lighter in tone since the DL values were positive which were 0.67 and 2.77 respectively. Conversely S-4, S-5 and S-6 were darker as the values were negative those were -0.98, -0.12 and -3.96 respectively. The total color difference DE values of S-1 and S-4 samples are 0.46 and 0.49 which indicates that the samples are matched with S-2. The DE values of other samples S-3, S-5 and S-6 are 1.65, 1.63 and 1.81respectively indicates that the samples are near or closer to the standard sample S-2. On the whole, it is seen that the DE values are in the range of 0 to 2 as compared to S-2, which indicates the differences in shade is comparable.

3.5 Fastness properties

From table 3, it is clearly observed that the color change in S-6 (grading 2-3 as per ISO standard) which was without salt and soda. It reveals that salt and soda was used in S-1 to S-5 those sample showed good

fastness properties. So, the fastness properties are poor of S-6 among all the samples. On the other hand, the excellent fastness properties were found in S-5. However, S-2 and S-4 have similar quality regarding color change.

Table 3. Color fastness to washing test results.

Samples	S-1	S-2	S-3	S-4	S-5	S-6
Change in color	3-4	4	3	4	4-5	2-3
Acetate	4-5	4-5	4-5	4-5	4-5	4-5
Cotton	4-5	4	4-5	4-5	4-5	4-5
Nylon	4-5	4-5	4-5	4-5	4-5	4-5
Polyester	4-5	4-5	4-5	4-5	4-5	4-5
Acrylic	4-5	4-5	4-5	4-5	4-5	4-5
Wool	4-5	4-5	4-5	4-5	4-5	4-5

Lowest color staining found in S-2 for cotton which was graded as 4 (staining to cotton as per ISO standard) but all other samples were found excellent grade for staining to multifiber which were graded as 4-5.The scoured and bleached cotton knit fabric samples were dyed with the extracted dye liquor from *Mikania micrantha* leaves, the dye fiber interaction and probable dye structure was not evaluated through NMR/FTIR instrument. It can be done in the further works.

Table 4. Color fastness to rubbing test results.

Samples	S-1	S-2	S-3	S-4	S-5	S-6
Dry	4-5	4-5	4-5	4-5	4-5	4-5
Wet	3-4	3-4	4-5	4-5	4-5	4-5

Table 4 represents the rubbing fastness (Dry and Wet) properties among the tested samples. It was observed that the dry rubbing fastness was excellent for all samples which were graded as 4-5 as per ISO standard. In contrast, wet rubbing fastness is moderate for sample 1 and sample 2. On the other hand the highest grade found in sample 4, 5 & 6 which was graded as 4-5.

4. Conclusion

From the above discussion, it can be revealed that the reflectance percentage values are increased with the increase of wavelength and conversely the color strength k/s values are decreased with the increase of wavelength in nm. Color fastness results also exposed that salt and soda was used in S-1 to S-5, those samples showed good fastness properties. The change in color due to wash in S-6 was poor rating in grey scale as it was dyed without any salt and soda. The total color difference DE of all the samples are in 0 to 2 as compared to sample 2, which indicates the differences in shade is comparable and it can be closer to further works. It can be concluded that there is an opportunity for *Mikania micrantha* leaves may be used as natural colorant as well as its anti-microbial properties can be further studied.

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