Eco-friendly process for dyeing banana fabrics with curcuma natural dyes.

Dr. Mohamed Mohamed Mosaad Kamel

Lectuerer at Textiles printing, dyeing and finishing, Faculty of Applied Arts, Benha University.

mohamed.kamel@fapa.bu.edu.eg

Dr. Yasmeen Abd El Aziz Mohamed Abo El Amaim

Lectuerer at Spinning,weaving and knitting department Faculty of Applied Arts.Beni Suef university

d_ego44@hotmail.com

Abstract

Banana fibers have a lot of superior physical and chemical properties which can be used as an excellent raw material for the textiles and packaging industry.

Banana, cotton blended woven fabrics were prepared by using different composition and histological structure. (based on three different banana fiber ratios in weft direction (50% banana: 50% cotton, 33.4% banana: 66.6% cotton & 25% banana: 75% cotton) respectively. With three weave structures (plain 1/1, twill 2/2 and satin 4) that differ from each other in the float length.

The objective of this research is to establish a suitable natural dyeing process for banana woven fabrics, then make a comparison between dyeing behavior of banana fabrics with cotton fabrics. Curcuma dye as an eco-friendly dye was studied to clarify the impact of natural dye with comparative studies of the K/S and over all fastness properties of dyed samples on natural banana/cotton (plain, twill and satin) fabrics. Finally, the dye uptakes and the color fastness behavior of the samples have been investigated with regards to the mordents and fiber ratios and weave structures.

Color Testing was conducted to assess the color properties between dyed banana fabrics, and cotton fabrics as well as plain, twill, and satin fabrics. Color measurements were performed by using a Data-color spectrophotometer.

Results showed that the banana fabrics can be dyed with Curcuma dye successfully. K/S values of banana samples are higher than cotton samples, irrespective of the nature of the mordant used. K/S values of the simultaneous mordanting acquired higher values than the pre-mordanting irrespective of the fabric (with plain, twill or satin constructions) used.

Color fastness to rubbing, and perspiration properties of blended banana/cotton is better than the cotton.

Therefore, cotton dyeing process can be applied for the banana fabrics. Dyeing of banana fiber was carried out with a natural curcuma type of dye, which provided better washing fastness properties than cotton fibers.

Keywords:

Banana fabrics, color fastness properties, dyeing, eco-friendly, curcuma dye, woven fabrics.

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الملخص:

تتمتع ألياف الموز بالكثير من الخصائص الفيزيائية والكيميائية الفائقة التي يمكن استخدامها كمواد خام ممتازة لصناعة المنسوجات.

تم تحضير الأقمشة المنسوجة من مخاليط القطن والموز باستخدام تراكيب نسجيه ونسب خلط مختلفة. (ثلاث نسب خلط من ألياف الموز في اتجاه اللحمة (٥٠٪ موز: ٥٠٪ قطن ، ٣٣,٤٪ موز: ٦٦,٦٪ قطن و ٢٥٪ موز: ٧٥٪ قطن) على التوالي. مع ثلاثة تراكيب نسجيه (سادة ١/١ ، مبرد ٢ / ٢ و ستان ٤) مختلفي في طول التشييفة.

يهدف البحث على كيفية صباغة أقمشة الموز بصبغات طبيعية مناسبة، ثم إجراء مقارنة بين صباغة أقمشة الموز مع الأقمشة القطنية.

تمت دراسة صبغة الكركم كصبغة صديقة للبيئة لتوضيح تأثير الصبغة الطبيعية وذلك من خلال الدراسات المقارنة لشدة اللون K/S و ثبات العينات المصبوغة على أقمشة الموز / القطن الطبيعي ذو تركيب (السادة ، والمبرد والستان). حيث تم قياس درجات امتصاص الصبغة ودرجات ثبات اللون للعينات فيما يتعلق بنسب خلط الألياف وعمليات النسج.

أظهرت النتائج إمكانية صباغة أقمشة الموز بصبغة الكركم بنجاح. حيث سجلت قيم شدة اللون لعينات الموز المخلوطة أعلى من شدة لون عينات القطن بغض النظر عن طبيعة الموردنت المستخدم. كما اكتسبت قيم شدة اللون للعينات المعالجة بالموردنت (اثناء عملية الصباغة) قيمًا أعلى من العينات المعالجة بالموردنت (قبل الصباغة) بغض النظر عن التركيب النسجي المستخدم (السادة أو المبرد أو الستان).

كما وجد ان درجات ثبات اللون للاحتكاك والعرق لعينات (المخاليط الموز / القطن) أفضل من القطن ١٠٠%.

لذا يمكن تطبيق عملية صباغة القطن على أقمشة الموز. حيث تم إجراء صباغة ألياف الموز بصبغة الكركم الطبيعي الصديق للبيئة، والتي وفرت خصائص ثبات أفضل للغسيل مقارنة بعينات القطن.

الكلمات المفتاحية:

موز؛ صباغة؛ كركم؛ بيئة؛ منسوجات

1. Introduction

Recently, increasing awareness of the organic value of eco-friendly products has led to increase interest in using natural textiles colored with natural dyes that do not harm the environment. [1]

Banana plant (scientific name: Musa acuminate) not only gives the delicious fruit but it also provides textile's fiber called the banana fiber.

Banana fiber is the extracted fiber from the Banana tree which is a waste material after harvesting the Banana. Other portions of Banana plant are dumped as waste; farmers often face problems to clear it. Due to weather conditions such as floods, heavy winds, the complete Banana trees falls, and creates a heavy loss. So, apart from these all there is a solution. Which the Banana trees can be extracted and converted to fiber, through simple Machinery. [2]

Since banana fiber is largely cellulose (65%) it should respond well to natural dyes. This seems a reasonable choice anyway, given the poetry of using a substance like banana in the first place. Banana, by the way, can be used as a dye itself. Depending on the color, certain plants such as Curcuma make excellent dyes. [3]

Banana pseudostem consists of 13 layers of the sheath, and an outer layer of 11 leaf sheaths in the pseudo stem that can be utilized for extracting fibers. [2]

Banana fiber is considered as a bast fiber, which was extracted from the pseudostem of banana plant, with nearly great mechanical properties, i.e., high strength, good moisture absorption quality, and biodegradability. [4]

Researchers [3,5] discovered that banana fiber has strong moisture absorption, lower elongation, and light weight. Banana fiber has a high potential to become a sustainable raw material for the textile industry moving toward green technology. [6]

Cellulosic fibers like banana fiber consist of micro-fibrils in an amorphous matrix of lignin and hemi-cellulose and cellulose. The strength and stiffness of the fibers were achieved by hydrogen bonds and other linkage. [7]

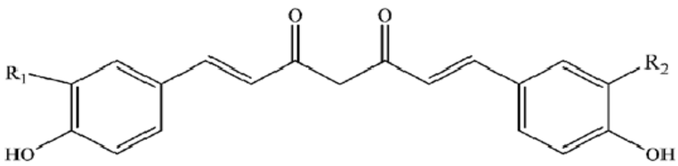
Synthetic dyes offer a wide range of colors, being inexpensive, easy to obtain and have good fastness properties. However, previous studies have proven that some of synthetic dyes are not biodegradable, and cause allergies, also might be toxic and carcinogenic. [8] Therefore, the demand has increased recently for environmentally friendly, non-cancerous and non-toxic products.

Dyeing plays an important role in the production of textiles and determines the quality of the product to be dyed.

Natural dyes are better than synthetic ones in that they are biodegradable, non-toxic, do not cause any health problems, are produced in moderate conditions, cheap, easy availability, and renewable reservoir to materials for many applications. [9]

Turmeric is a product of Curcuma longa, a rhizomatous herbaceous perennial plant belonging to the ginger family Zingiberaceae, which is native to tropical South Asia. The rhizome, from which the turmeric is derived, is tuberous, with a rough and segmented skin. When the turmeric rhizome is dried, it can be ground to a yellow powder with a bitter, slightly acrid, yet sweet, taste. In a standard form, turmeric contains moisture (>9%), curcumin (5–6.6%), extraneous matter (<0.5% by weight), mold (<3%), and volatile oils (<3.5%). [10]

The pigments in the colorant extracts obtained from Curcuma collectively known as curcuminoids, the major constituent being curcumin, along with small amounts of demethoxycurcumin and bisdemethoxycurcumin Fig (1) [11, 12]



R1 = OCH_3, R2 = OCH_3 - curcumin
R1 = R2 = H - bisdemethoxycurcumin
R1 = OCH_3, R2 = H - demethoxycurcumin

Fig (1): Structure of curcumin and its analogs

The recent studies have demonstrated the dyeing of banana fibers. [13]

This experiment aims to evaluate the suitable dyeing process for the banana woven fabrics and present work focused on the comparison between dyeing of banana blended fabrics with cotton fabrics. The effect of different fabric's composition and histological structure between banana fiber and cotton fiber samples colorimetric values and all fastness properties were studied.

Materials and methods:

1. Materials

1.1. Substrates: The material warp threads of all produced samples was 100% cotton with yarn count 50/2 Ne, about the weft, it was: 100% cotton yarn and blended yarn (50% banana: 50% Cotton) were used for the weft with yarn count 20/1 Ne, the below table (1) shows weft & warp yarns properties. Blended yarn (50% banana: 50% Cotton) was supplied by Banfab co. Ltd, India.

Table (1) Mechanical properties of weft and warp yarns.

Sample	direction	count
100% cotton	wrap	50/2 Ne
Blended (50% Banana fiber : 50% cotton fiber)	weft	20/1 Ne
100% cotton	weft	20/1 Ne

To investigate the effect of banana fiber ratio on the produced fabrics properties, ten samples were produced by using two parameters (weft ratio & weave structure). Three different arrangement of the weft yarns were used for producing research samples which leads to a difference in the banana fiber concentration, with three weave structures (plain 1/1 & Twill 2/2 and Satin 4) as shown in Table (2).

Table (2) The operational specifications of produced samples.

Sample number	**Weave structure** (variable parameter)	**Weft ratio** (variable parameter)	**Weft arrangement**	**Ends /cm** (constant parameter)	**Picks/cm** (constant parameter)
1	Plain 1/1	75% Cotton : 25% Banana	1 Cotton : 1 Blended	36	21
2			1 Cotton : 2 Blended		
3			Blended		
4	Twill 2/2	66.6 % Cotton : 33.4 % Banana	1 Cotton : 1 Blended		
5			1 Cotton : 2 Blended		
6			Blended		
7	Satin 4	50 % Cotton :50% Banana	1 Cotton : 1 Blended		
8			1 Cotton : 2 Blended		
9			Blended		
10	Plain 1/1	100% cotton	cotton		

1.2. Dyestuff: Natural Colouring substance turmeric (Curcuma) [which have been purchased from local market] was extracted according to the procedure described latter.

1.3. Mordants: Alum [hydrated aluminium potassium sulphate ($KAl(SO_4)_2.12H_2O$], Copper Sulphate $CuSO_4(H_2O)_{x=(0-5)}$, and Ferrous Sulphate $FeSO_4$.

1.4. Other chemicals: Acetic acid, sodium sulphate, and sodium carbonate were of Laboratory grade chemicals.

2. Methods:

2.1. Scouring Process:

The banana samples weighing 5 grams were applied to the scouring process in 3% sodium hydroxide solution (based on the weight of the fabrics: o.w.f) at the boil for one hour before having been neutralized with acetic acid and finally the samples dried.

2.2. Extracting of natural coloring matter:

100 g. curcuma “turmeric” dry powder were added to 1000 ml. distilled water and subjected to boiling under reflux for 30 min. The mixture was left to cool at room temperature and then filtrated off. The filtrated solution was concentrated using a laboratory rotavapor.

2.3. Mordanting of natural fabrics:

Mordanting of the weave samples (plain 1/1 , Twill 2/2, and Satin 4) were conducted using two different techniques; either pre-mordanting or simultaneous i.e. added directly to the bath were used.

pre-mordanting: The banana samples were mordanted with Alum mordent before the dyeing process. The samples were undergone the mordant process at the boiling temperature for 60 minutes at pH 4 in the mordent liquors prepared in the mordent liquors ratio of 1/20 with a variety of mordent regarding to the material weight, then the samples were cooled and finally squeezed and dried.

simultaneous mordanting (one-pot method): The banana samples were mordanted with a variety of mordent (Alum, or Copper Sulphate, or Ferrous Sulphate) at the same bath of dyeing process.

2.4. Dyeing methods:

The blended banana and cotton fabrics (plain 1/1 , Twill 2/2, and Satin 4) were dyed using the aforementioned extracted curcuma natural colour in the presence of sodium sulphate (20 g/L). The pH was adjusted at 6.5 using acetic acid at L.R. 1:50.

The samples were added to the dyeing bath at 30 ˚C then the temperature was raised to 75 ˚C for 10 minutes. The samples were left at 75 ˚C for one hour.

After the dyeing process was concluded, the samples were left to cool themselves in the liquor. Then the samples were rinsed with running tap water. the samples were washed with hot water at 60 ˚C, rinsed with cold water and finally air dried.

The dyeing process was carried out with stirring with mordant or without mordant.

3. Testing, Analysis, and measurements:

3.1. Color strength and fastness:

The colour strength (K/S) of the samples was evaluated by light
reflectance technique using Shimadzu UV/Visible spectrophotometer [14] .

The colour strength expressed as K/S value was assessed by applying the Kubelka equation as follows:

$(1-R)^2$ $(1-Ro)^2$

$$K/S = \frac{\quad}{2R} - \frac{\quad}{2R_o}$$

Where:

R = Decimal fraction of the reflectance of the dyed fabric.

Ro = Decimal fraction of the reflectance of the un-dyed.

K = Absorption coefficient

S = Scattering coefficient.

And the colour overall fastness properties: i.e. to washing, rubbing, or perspiration fastness were assessed according to standard methods [15].

3.2. Color fastness to rubbing:

The colour fastness to rubbing was determined according the AATCC test method 8-1996, International Organization for Standardization (ISO) 105X12. Include dry and wet rubbing test. [16]

3.3. Color fastness to washing:

The colour fastness to washing was determined according to the International Organization for Standardization (ISO) 105-C06 A2S: 1994 standards (AATCC test method 36-1972). [17]

3.4. Color fastness to perspiration:

The colour fastness to perspiration was determined according to the ISO 105 E04 :2013, AATCC 15: 2009. [18] Include acidic and alkaline solution test.

The effect on the colour of the test samples was expressed and defined by reference to the Gray scale for colour change.

4. Results and Discussion:

4.1. Effect of mordanting technique on K/S of dyed fabrics with curcuma colorant:

4.1.1. On plain fabrics:

To study different mordanted techniques (pre-mordanting and simultaneous mordanting) of Alum mordant and their effects on dyeing curcuma on banana/cotton blended or cotton samples and compared with non-mordanted samples.

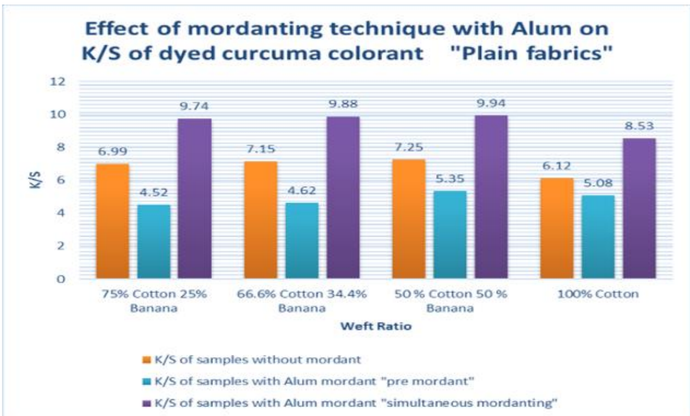


Fig. (2): Effect of using curcuma natural dye on dyeing plain fabrics in presence of Alum with different techniques.

It is clear from the data of figure (2) that, irrespective of the methods of mordanting used, the obtained K/S values of dyed samples increases, by increasing the banana fibre ratio.

It is also clear from the data that, the highest K/S was obtained on using the simultaneous mordanting technique in all banana ratio than other techniques.

By comparison; banana 50:50 cotton blended fabrics with 100% cotton fabrics, banana's blended samples obtained higher K/S than 100% cotton samples regardless the mordanting technique used.

4.1.2. On Twill 2/2 fabrics:

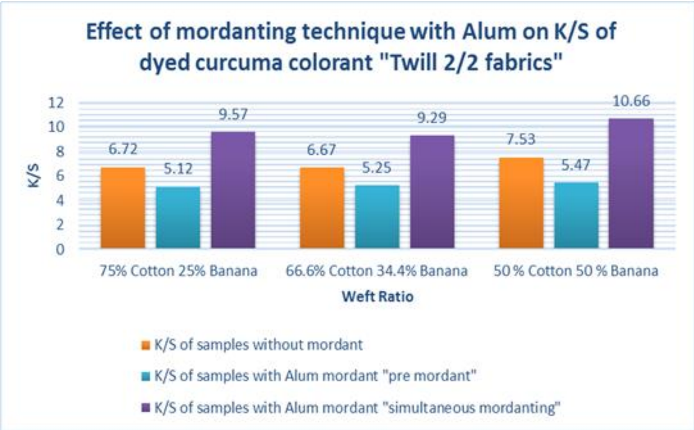


Fig. (3): Effect of using curcuma natural dye on dyeing Twill 2/2 fabrics in presence of Alum with different techniques.

It is clear from the data of figure (3) that, the highest K/S was obtained on using "cotton 50:50 Banana" on Twill 2/2 dyed samples with curcuma, irrespective of the methods of Alum mordanting used.

In case of the simultaneous samples obtained K/S values higher than pre-mordanted samples.

In addition, simultaneous mordant "banana 25%:75% cotton" samples acquire K/S values more than "banana 34.4%:66.6% cotton" samples.

4.1.3. On Satin 4 fabrics:

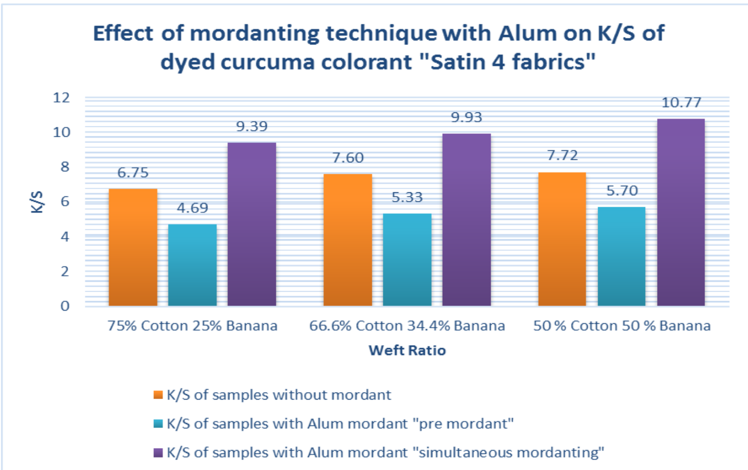


Fig. (4): Effect of using curcuma natural dye on dyeing Satin 4 fabrics in presence of Alum with different techniques.

It is clear from the data of figure (4) that, the highest K/S was obtained on using "50% cotton: 50% Banana", was 10.77 and 5.70, for dyeing with simultaneous mordant and with pre-mordanted respectively.

It is also clear from the data that, by increasing the Banana ratio the K/S increases.
In addition, the Satin4 samples dyed with curcuma in presence of Alum mordant obtained the higher K/S value than Twill 2/2 and Plain samples, for examples 10.77, 10.66 and 9.94 respectively on “50% cotton: 50% Banana” samples.
It is worthy mention that the un-mordanted samples obtained the K/S values higher than pre-mordanting samples.

4.2. Effect of mordant types on K/S of dyed fabrics with curcuma colorant: using simultaneous mordanting technique.

To study different mordant types (Alum, Copper Sulphate, and Ferrous Sulphate mordant) and their effects on dyeing curcuma on banana/cotton blended or cotton samples, and were compared with non-mordanted samples.

4.2.1. On Plain 1/1 fabrics:

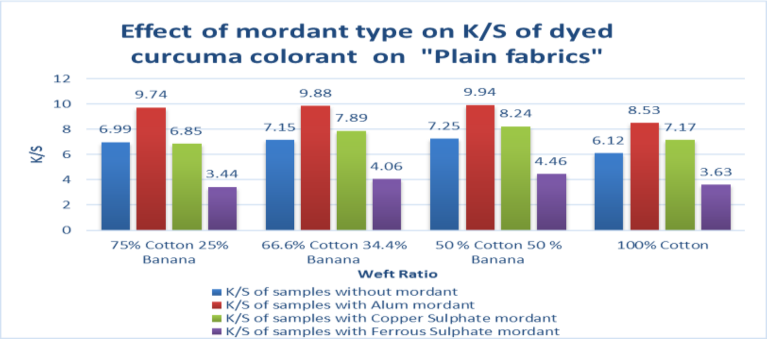


Fig. (5): Effect of using curcuma natural dye on dyeing plain fabrics in presence of different mordants.

It is clear from the data of figure (5) that, by increasing the banana ratio used; the K/S values of dyed samples increases, irrespective of the mordant type used. In case of un-mordant samples, results represent the same trend with mordanted ones.
Moreover, the highest K/S value was obtained on using Alum mordant then Copper sulphate then ferrous sulphate, for examples on (50% banana: 50% cotton) the K/S values were 9.94, 8.24, 4.46 respectively. By comparing “100% cotton” with blended “banana/cotton” dyed samples, (34.4% banana: 66.6%cotton) and (50% banana: 50% cotton) obtained K/S values higher than 100% cotton samples irrespective of mordant type used.

4.2.2. On Twill 2/2 fabrics:

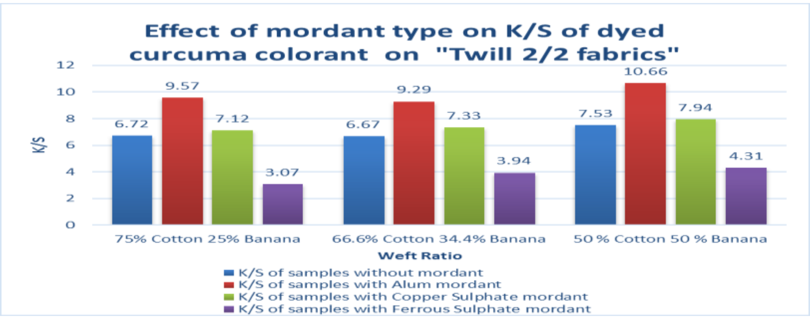


Fig. (6): Effect of using curcuma natural dye on dyeing twill 2/2 fabrics in presence of different mordants.

It is clear from the data of table (4) and figure (6) that, the highest K/S was obtained on using "50% cotton: 50% Banana", irrespective of the mordant type used, were 10.66, 7.94, 4.31, 7.53 with using Alum, copper sulphate, Ferrous sulphate or without mordant respectively.
On using Copper sulphate or ferrous sulphate, the K/S values increase by increasing the banana ratio on blended weft.

4.2.3. On Satin 4 fabrics:

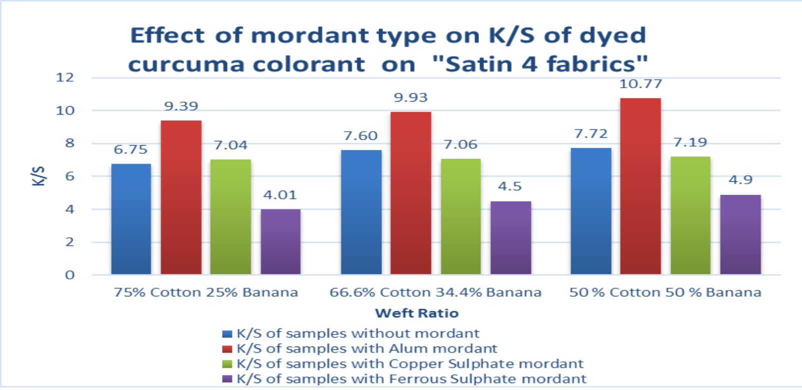


Fig. (7): Effect of using curcuma natural dye on dyeing satin4 fabrics in presence of different mordants.

It is clear from the data of figure (7) that, by increasing the banana ratio used; the K/S values of dyed samples increases, irrespective of the mordant type used, also in presence or absence of mordant.
It is also clear from the data that, the highest K/S was obtained on using "50% cotton: 50% Banana", irrespective of the mordant type used.
In addition, the K/S values were obtained on using the Alum mordant is higher than Copper sulphate or ferrous sulphate mordant.
In case of the ferrous sulphate mordant the K/S values is less than the dyed samples without mordant.

4.3. Effect of weave structure of fabrics on K/S of dyed fabrics with curcuma colorant:

To study different weave structure (Plain, Twill2/2, and satin4) and their effects on dyeing curcuma on banana/cotton blended or 100% cotton samples, in presence and absence of mordants (Alum, Copper Sulphate, and Ferrous Sulphate mordant) and compared with non-mordanted samples.

4.3.1. On cotton 66.6%: 34.4% Banana fabrics:

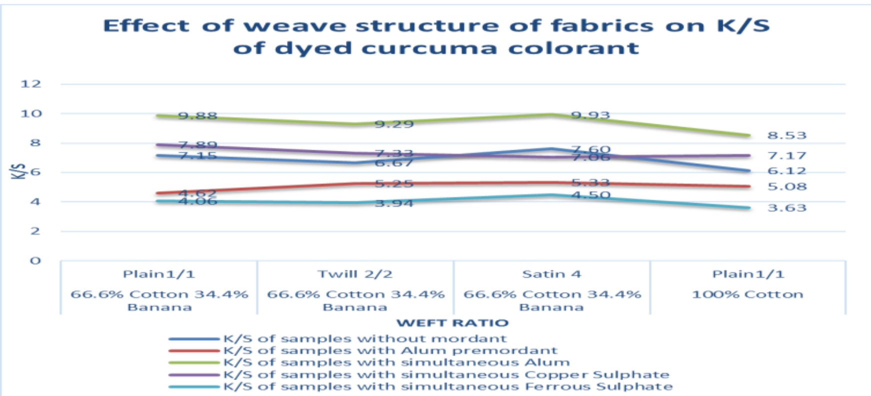


Fig. (8): Effect of weave structure of fabrics on K/S of dyed curcuma in presence and absence of mordants.

It's clear from the data of figure (8) that, Satin 4 samples obtained the highest K/S values on using Curcuma dye in presence and absence of mordants than other weave structures, for examples the K/S values were 7.60, 5.33, 9.93, and 4.50 for dyeing without mordant, with pre-mordanted and with simultaneous mordants (Alum, or Ferrous Sulphate) respectively. While in case of using Copper Sulphate as a mordant the highest K/S value obtained on using Plain 1/1 (66.6% Cotton 34.4% Banana) fabrics, was 7.89.

4.3.2. On cotton 50%: 50% Banana fabrics:

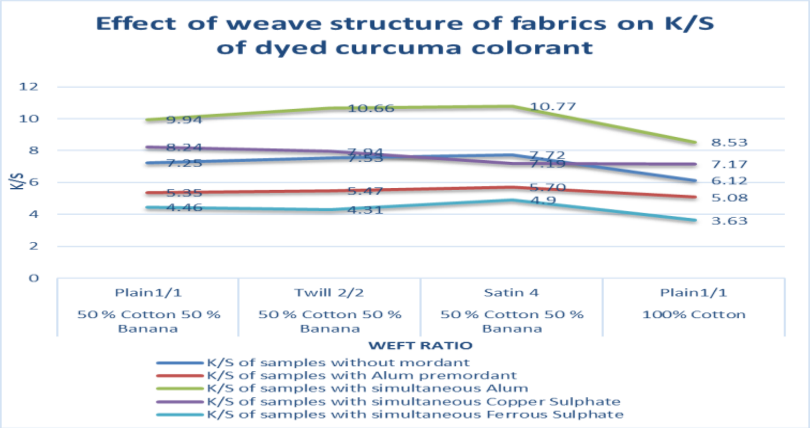


Fig. (9): Effect of weave structure of fabrics on K/S of dyed curcuma in presence and absence of mordants.

It's clear from the data of figure (9) that, Plain 1/1 blended banana/cotton samples obtained the higher K/S values than Plain 1/1 100% cotton samples on using Curcuma dye in presence and absence of mordants than other weave structures.

In case of (50% cotton: 50% Banana) samples, results represent the same trend with (66.6% Cotton 34.4% Banana) samples as previously reported. For example, the highest K/S values on using Curcuma dye in presence and absence of mordants than other weave structures, for examples the K/S values were 7.72, 5.70, 10.77, and 4.90 for dyeing without mordant, with pre-mordanted and with simultaneous mordants (Alum, or Ferrous Sulphate) respectively. While in case of using Copper Sulphate as a mordant the highest K/S value obtained on using Plain 1/1 (50% Cotton 50% Banana) fabrics, was 8.24.

Table (3,4): Color strength (K/S) and overall fastness properties of plain 1/1, Twill 2/2, and Satin 4 dyed with curcuma.

Samples No.	Samples					Washing fastness		Rubbing fastness		Perspiration			
	Weave structure	Weft Ratio	Weft arrangement	Mordant	K/S of dyed fabric					Acidic		Alkaline	
						Alt.	St.	Dry	Wet	Alt.	St.	Alt.	St.
1	Plain1/	75% Cotton	1 Cotton : 1 Blended	Without mordant	6.99	3-4	3-	4	3-4	4	3-	3-4	3-
2	Twill				6.72	3-4	3-	4	3-4	3-4	3-	3-4	3-
3	Satin 4				6.75	3-4	3-	3-4	3-4	3-4	3-	3-4	3-
4	Plain1/	66.6% Cotton	1 Cotton : 2 Blended		7.15	3-4	3-	4	4	3-4	3-	3-4	3-
5	Twill				6.67	3-4	3-	4	3-4	3-4	3-	3-4	3-
6	Satin 4				7.60	3-4	3-	4	3-4	3-4	4	3-4	4
7	Plain1/	50 % Cotton	Blended		7.25	3-4	3-	4	4	4	4	3-4	3-
8	Twill				7.53	3	3-	3-4	3-4	3-4	3-	4	3-
9	Satin 4				7.72	3-4	3-	4	3-4	3-4	3-	3-4	3-
10	Plain1/	100%	Cotton		6.12	3-4	3-	4	4	3-4	4	4	4
11	Plain1/	75% Cotton	1 Cotton : 1 Blended	With Alum “ Pre-	4.52	3-4	3-	4	4	4	3-	4	3-
12	Twill				5.12	3-4	3-	3-4	3-4	3-4	3-	3-4	3-
13	Satin 4				4.69	3-4	4	3-4	3-4	4	3-	4	3-
14	Plain1/	66.6% Cotton	1 Cotton : 2 Blended		4.62	3-4	4	3-4	3-4	4	4	4	4
15	Twill				5.25	3-4	4	4	3-4	4	3-	3-4	3-
16	Satin 4				5.33	3	3-	3-4	3	3-4	3-	3-4	3-
17	Plain1/	50 % Cotton	Blended		5.35	3-4	4	4	4	3-4	3-	4	3-
18	Twill				5.47	3-4	3-	3-4	3-4	4	3-	4	4
19	Satin 4				5.70	3-4	3-	4	4	4	3-	4	3-
20	Plain1/	100%	Cotton		5.08	3-4	3-	4	4	4	4	4	4
21	Plain1/	75% Cotton	1 Cotton : 1 Blended	With Alum	9.74	4-5	3-	4-5	3-4	4	4	4	4
22	Twill				9.57	4-5	4	4-5	4	4	4	4	4
23	Satin 4				9.39	4-5	4	4-5	4-5	4-5	3-	4-5	4
24	Plain1/	66.6% Cotton	1 Cotton : 2 Blended		9.88	4-5	4	4-5	4-5	4	4	4-5	4
25	Twill				9.29	4-5	4	4-5	4-5	4-5	4	4	4
26	Satin 4				9.93	4-5	4	4-5	4-5	4-5	4	4-5	4
27	Plain1/	50 % Cotton	Blended		9.94	4-5	4	4-5	4-5	4-5	4	4	4
28	Twill				10.6	4-5	4	4-5	4-5	4-5	4	4	4
29	Satin 4				10.7	4-5	4	4-5	3-4	4-5	4	4-5	4
30	Plain1/	100%	Cotton		8.53	4-5	4	4-5	4-5	4-5	4	4-5	4
		Alt.: Alteration St.: Staining											

Samples No.	Samples					Washing fastness		Rubbing fastness		Perspiration			
	Weave structure	Weft Ratio	Weft arrangement	Mordant	K/S of dyed fabric					Acidic		Alkaline	
						Alt.	St.	Dry	Wet	Alt.	St.	Alt.	St.
31	Plain1/1	75% Cotton 25%	1 Cotton : 1 Blended	With Copper Sulphate	6.85	4-5	4	4	4	3-4	3-	3-4	4
32	Twill 2/2				7.12	4-5	3-4	4-5	4-5	3-4	4	2-3	3
33	Satin 4				7.04	4-5	4	4-5	4-5	3	3	3	3-
34	Plain1/1	66.6% Cotton 34.4%	1 Cotton : 2 Blended		7.89	4-5	3-4	4-5	4-5	3	3-	3	3-
35	Twill 2/2				7.33	4-5	4	4-5	4-5	3	2-	2-3	2-
36	Satin 4				7.06	4-5	4	4-5	4-5	3-4	3-	3	3-
37	Plain1/1	50 % Cotton 50 %	Blended		8.24	4-5	4	4-5	4-5	3	3	2-3	2-
38	Twill 2/2				7.94	4-5	4	4-5	4-5	3	3	2-3	2-
39	Satin 4				7.19	4-5	4	4-5	4-5	3	3	3	3
40	Plain1/1	100%	Cotton		7.17	4-5	4	4-5	4-5	3	3	3	2-
41	Plain1/1	75% Cotton 25%	1 Cotton : 1 Blended	With Ferrous Sulphate	3.44	4	4	4-5	4	3	3-	3	3
42	Twill 2/2				3.07	4-5	4-5	4	4	3	3	3	3
43	Satin 4				4.01	4-5	4-5	4-5	4	2-3	3	2-3	3
44	Plain1/1	66.6% Cotton 34.4%	1 Cotton : 2 Blended		4.06	4	4-5	4	3-4	2-3	3	3	3
45	Twill 2/2				3.94	4-5	4-5	4-5	4	2-3	3	3	3
46	Satin 4				4.50	4	4-5	4	4	2-3	3-	3	3
47	Plain1/1	50 % Cotton 50 %	Blended		4.46	4-5	4-5	4-5	4	2-3	3	3	3
48	Twill 2/2				4.31	4-5	4-5	4	3-4	3	3	3	3
49	Satin 4				4.90	4	4-5	4	4	3	3	2-3	3
50	Plain1/1	100%	Cotton		3.63	4	4-5	4	4	3	3	3	3

Alt.: Alteration St.: Staining

The colour fastness properties of the natural fabrics (blended banana/cotton or 100% cotton) dyed with curcuma in presences of different mordants (Alum or Copper Sulphate or Ferrous Sulphate) or without mordant were measured. Tables (3,4) represents the data for the K/S values and the colour fastness to washing, to rubbing, and to perspiration for deferent weave structure (Plain1/1 – Twill 2/2 – Satin 4) dyed with curcuma.

The first glance at the result of table would imply that the colour strength (K/S) for the dyed samples with Alum “simultaneous mordants” is higher than with Alum “Pre-mordant” or without mordant.
In case of without mordant and Pre-mordant with Alum, the data shows that washing, rubbing, and perspiration properties ranging from good to very good.

While In case of simultaneous mordants the data shows that washing and rubbing perspiration properties ranging from very good to excellent. whereas the perspiration ranges from good to very good for Alum mordant, and ranges from slightly fair to good for Copper Sulphate mordant samples and finally ranges from slightly fair to moderate for Ferrous Sulphate

Conclusions:

• Banana woven fabrics were successfully dyed by using Curcuma natural colorant.
• By increasing the banana fibre ratio, the obtained K/S values of dyed samples increases, irrespective of the methods of mordanting used.

• The highest K/S was obtained on using the simultaneous mordanting technique in all banana ratio than other techniques.
• By comparison banana 50:50 cotton blended fabrics with 100% cotton fabrics, banana's blended samples obtained higher K/S than 100% cotton samples regardless the mordanting Technique used.
• By comparison weave structure of banana 50:50 cotton blended fabrics, Satin 4 samples obtained highest K/S than plain or Twill fabrics.
• Moreover, the highest K/S value was obtained on using Alum mordant then Copper sulphate then ferrous sulphate,
• While in case of using Copper Sulphate as a mordant the highest K/S value obtained on using Plain 1/1.
• washing and rubbing perspiration properties of simultaneous mordants ranges from very good to excellent mordant samples.

References:

[1]. Bhatti, I.A., Adeel, S., et al.; Influence of gamma radiation on the colour strength and fastness properties of fabric using turmeric (Curcuma longa L.) as natural dye, Radiation Physics and Chemistry 79, 622–625, (2010).
[2]. Manilal VB and Sony J. Banana pseudo stem characterization and its fibre property evaluation on physical and bio extraction. J Nat Fibres; 8(3): 149–160; (2011).
[3]. Mukhopadhyay, S., Fangueiro, R., Yusuf, A. and Senturk, U., "Banana fibres variability and fracture behavior" Journal Engineered Fibres and Fabrics, 3(2), pp. 39- 45; (2008).
[4]. Gupta G and Bhatnagar RA.; "Review on composition and properties of bagasse fibres."; Int. J Sci Eng. Res; 6(5): 143-148; (2015).
[5]. S. Asmanto, C. Achmad, "Banana Pseudo-stem fibre: preparation, characteristics, and applications", Intech Open, 10.5772/intechopen.82204, (2018).
[6]. Padam BS, Tin HS, Chye FY, et al.; "Banana by-products: an under-utilized renewable food biomass with great potential."; J Food Sci. Techno; 51(12): 3527–3545; (2014).
[7]. Amir N, Abidin KAZ and Shiri FBM.; "Effects of fibre configuration on mechanical properties of banana fiber/PP/MAPP natural fibre reinforced polymer composite." Procedia Engineer; 184: 573-580; (2017).
[8]. Bechtold, T., Amalid, A.M., and Mussak R.; "Natural dyes for textile dyeing: A comparison of methods to assess the quality of Canadian goldenrod plant material", Dyes and Pigments;; 75, 287-293; (2007).
[9]. Araújo, C.A.C., Leon, L.L., Biological Activities of Curcuma longa L., Mem. Inst. Oswaldo Cruz, 96(5): 723-728, (2001).
[10]. Benzie IFF, Wachtel-Galor S; "Herbal Medicine: Biomolecular and Clinical Aspects." Boca Raton (FL): CRC Press/Taylor & Francis; 2nd edition; (2011).
[11]. Bechtold T. and Mussak R.; "Handbook of Natural Colorants." John Wiley & Sons Ltd, (2009).
[12]. Ragheb AA, Tawfik S, Abd–El Thalouth JI, Mosaad MM. "Development of printing natural fabrics with curcuma natural dye via nanotechnology". Int J Pharmaceutical Sci Res., 8(2): pp 611- 620, (2017).

[13]. S. Balakrishnan et el; "Study on dyeing behaviour of banana fibre with reactive dyes"; Journal of Engineered Fibres and Fabrics; Volume 14: 1 –12; (2019).

[14]. J. Neves, "Technologia Textil", LLS Edn., Porto, Portugal; Vol. l; (1982).

[15]. The Society of dyer and colourists; "Standard methods for the Assessment of colour fastness of textiles", Third Report of the fastness tests coordinating committee, Yorkshire, England, (1955), 71, p.24

[16]. AATCC Test Method 8-1996; International Organization for Standardization (ISO) 105X12.

[17]. AATCC test method 36-1972; International Organization for Standardization (ISO) 105-C06 A2S: 1994 standards.

[18]. AATCC 15: 2009; International Organization for Standardization ISO 105 E04 :2013.