Extraction of Plants Dye from Different Parts of Banda (*Terminalia cattapa* L.) and Its Coloration Effect on Clothes

Yee Yee New[1], Moe Moe Khaing[2], Khin Myo Thwe[3], Thet Phoo Wai[4]

Abstract

Synthetic chemical dyes can release vast amount of pollutant into our ecosystem and are hazardous and carcinogenic. Thus plant scientists revived the natural dyeing techniques as one of the alternatives to remediate the environmental pollution. The use of non-toxic and eco-friendly natural dyes on textiles has become a matter of significant importance because of the increased environmental awareness in order to avoid some synthetic dyes, Mosteffective ways for reducing environmental pollution are the replacement of polluting materials and chemicals by eco-friendly natural materials. Many natural resources which are being wasted indiscriminately and thrown away as a waste product contain useful dyes and pigments. In the present study, natural dye extracted from the leaves, barks and fruits of Banda (*Terminalia cattapa* L.) (tropical almond) and its application on cloth pretreated with chemical mordants (alum, quick lime and sodium acetate) have been carried out. The dyeing conditions of crude extract are applied on the pieces of Muslin cloth (14 x 11 cm) size in the pH ranging from 4 to 9. Different shades with excellent to good fastness properties have been obtained in the different coloration yellowish black, yellow blackish red, yellowish red ,dark reddish yellow and bright yellowish red.

Keywords: Natural dyes extracted from the leaves, barks and fruit of Banda

Introduction

Natural dyes are colorants extracted from plants, invertebrates, or minerals, The greater number of natural dyes are vegetable dyes from plant sources, e.g. Indigo .Although the natural dyes were used to color clothing with the development of human civilization and culture historically, chemists began to produce synthetic dyes by the mid -1800s. They substituted the use of plants dyes with synthetic chemical dyes without knowing enormous issues and environmental impacts. By the early part of 19th century ,only a small percentage of textile dyes were extracted from plant. Until the latter half of the 19th century people were using natural dyes Parkes (2002) for colouring the texile fiber after invention of synthetic dyes , natural dyes are not used because of the advantage of synthetic dye over natural dye in respect of application, colour range, fastness properties , and availability . Some synthetic dyes are hazardous, carcinogenic and also release vast amount of pollutant in the environment during their manufacturing (Nagia and EI-Mohamedy , 2007).*Terminalia cattapa* L. is known for its nutritional fruit and possesses medicinal benefits as well as dye producing plant. *Terminalia cattapa* L. has been recognized for its medicinally essential phytoconstituents, such as phenol, flavonoid and carotenoid. Numerous pharmacological investigations have confirmed this plants ability to exhibit antimicrobial, anti-inflammatory, antidiabetic, antioxidant, hepatoprotective and anticancer activities, all of which support its traditional uses. Natural dyes from most flora and fauna are usable alternatives to chemically synthetic dyes.

In 2017, Manuel showed that *Terminalia cattapa* L. (banad) leaves are good sources of natural colorant producing green, yellow and black pigments , depending on the freshness of the leaves. The vast quantity of hazardous chemicals was released into our environmental during the production and application of natural dyes. In Myanmar, the interest in natural dyes is gradually increasing and the plants dyes are

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being perceived to provide an environment –friendly dyed fabrics and garments especially by tourists from around the world. Natural dyes can give us the feel of a superior quality sensory experience. There are five classic and popular natural dyestuffs, such as indigo , madder, cochineal, weld and cutch. Natural dyes show the properties of very strong yields, resistance to fading, relatively fast colors along with easy availability. Due to increasing reputation of more natural style of living based on naturally sustainable goods, recent increase on natural dye producing and application is recognized. The present work aims to study the initiation of producing plant dyes from Bandar plant debris (eg. Leaves, fruits, barks) which gives litters to our environments.

Objectives

- To study natural dyes and pigments from different parts of Banda
- To study the simple and effective method for the producing of natural dyes and their characteristics
- To study the effect of chemicals mordant, pH, time duration

Material and Methods

Collection and Preparation of Resource Plant

The resource plants are collected in the inside and outside around the University Campus, paddy fields, main roadside and other are taken out from the village Collection of Dyes producing plants from Htandabin Township. Extraction of dye by the method used in Saunders' Weaving Institute. Study on the effects of fastness of colours-

(i) Various pH
(ii) Different Dyeing Time (duration of treatment)
(iii) Various concentration of Different Mordant
(iv) Duration of Heating Time (depend on heating)

Extraction of Natural Dyes from Resource Plants

Plants dyes and pigments extracted by the method of Saunders' Weaving Institute with some modifications. The use of fresh leaves, bark and fruit is recommended to obtain the best color. These materials are chopped into fine bits, placed in a pot and boiled. After boiling for Different Dyeing Time , the extract is strained. This process is repeated twice or four times to get the bulk extract of dyes. The basic objective is to obtain a concentrated extract. However, depending on plant materials used, the boiling process can be increased or decreased. When the extract is obtained, it is passed through a silk sieve to remove foreign matter.(Saunders' Weaving Institute, Amarapura Township, and Mandalay Division.)

Botanical Name	*Terminaliacatappa* L.
Myanmar Name	Banda
Family	Combretaceae
Part used	Leaves, Bark, fruits, (Hoker, 1894)

Cloth dyeing and fastness of colour

The cloth or thread is then immersed into various liquid dye for 15, 30 and 60 minutes. pH of the liquid dyes are adjusted to 4,5,9 for leaves 3,4,9 for fruit and 4,5,9 for bark of *Terminaliacatappa L.* respectively.It is left to cool and then treated in a mordant bath. The above mordant is dissolved in water to make a mordant bath. The dyed cloth is placed in this bath for 5 minutes and then washed in water. After washing, the cloth is left for air dry until the desired colour is obtained.

Mordants

The dye colour are obtained by simmering, extracting the juice or by the fermentation. But often the colour of the dyed material disappears or changes.

Mordant help to bind the dyes to the fibers and can change the resulting colour of the dyes. There are various kinds of mordant although most are metallic salts. In the present study, the mordant which are easily available and cheap materials are used: The mordant used in present study: Saw kay Thi Linn (2005), Ya Min Thein (2005) and Than Than Aye (2006).

(i) Alum (Amyl acetate or aluminum acetate) 0.2%, 0.4% and 1.2%
These mordant do not damage the fibers.

(ii) Quick lime (CaO) 0.2%, 0.4% and 1.2%
Let the particles settle, use only the top liquid careful.

(iii) Sodium acetate (CH_3COONa) 0.2%, 0.4% and 1.2%
This mordant will be colorless deliquescent salt has a wide range of uses.

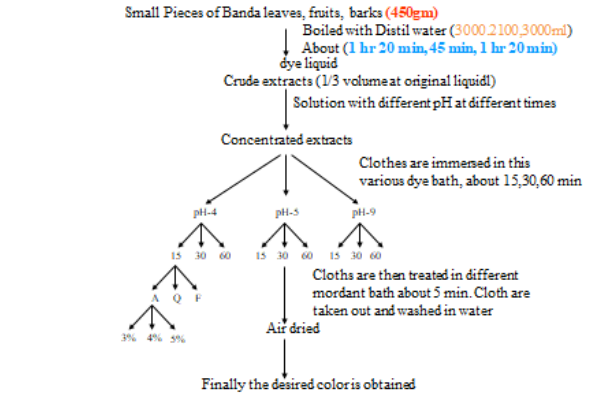
Materials for Dyeing

The cloth and threads used for dyeing are all natural fibres. Wool is generally the best fiber to colour with natural dyes. Synthetic fibers usually cannot be dyed with natural dyes. In the present work cotton cloths is used to test dyeing as well as in the study of fastness the same.

Scouring

To ensure even dyeing of the threads or cloth, it is necessary to remove any surface impurities such as gums, starches, etc. from the cloth or thread before dyeing. This cleaning process is called, "scouring", and the method varies according to the material. In the present study Muslim cloth is used along the experiment and the scouring method of Akiyama (1992) was applied with slight modification.

Results



A = Alum Juice 0.2%, 0.4%, 1.2%
Q = Quick Lime Juice 0.3%, 0.4%, 1.2%
F = Ferric Oxide 0.2%, 0.4%, 1.2%

Fig (1) Flow sheet of dyeing process in present experiment

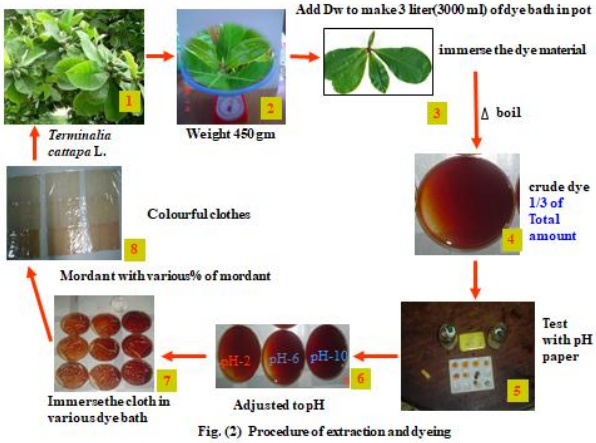


Fig. (2) Procedure of extraction and dyeing

Table (1) Fastness Properties of Banda leaves Treated with 0.2% of Different Mordant.

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	[+]	[+]	[+]	Yellowish black
T2	5	Alum	[+]	[+]	[+]	Yellowish black
T3	9	Alum	+	+	+	Yellowish black
T4	4	Quick lime	[+]	[+]	[+]	Yellow blackish red
T5	5	Quick lime	[+]	[+]	[+]	Yellow blackish red
T6	9	Quick lime	+	+	+	Yellowish red
T7	4	Sodium Acetate	+	[+]	+	Yellow reddish black
T8	5	Sodium Acetate	+	+	+	Yellow reddish black
T9	9	Sodium Acetate	+	+	+	Yellowish red

[+] = High + = Medium - = Low

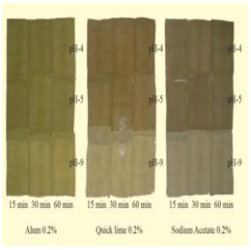


Fig. (3) Colour pattern of dye cloths with crude dye solution extracted from Banda leaves

Table (2) Fastness Properties of Banda leaves Treated with 0.4% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	+	+	+	Yellowish black
T2	5	Alum	+	+	+	Yellowish black
T3	9	Alum	-	-	-	Yellowish black
T4	4	Quick lime	+	+	+	Yellow blackish red
T5	5	Quick lime	+	+	+	Yellow blackish red
T6	9	Quick lime	+	-	-	Yellowish red
T7	4	Sodium Acetate	+	+	+	Yellow reddish black
T8	5	Sodium Acetate	+	+	+	Yellow reddish black
T9	9	Sodium Acetate	-	-	-	Yellowish red

[+] = High + = Medium - = Low

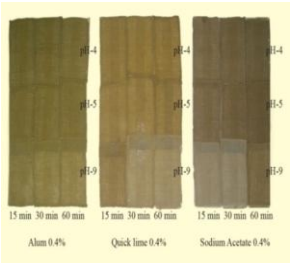


Fig. (4) Colour pattern of dye cloths with crude dye solution extracted from Banda leaves

Table (3) Fastness Properties of Banda leaves Treated with 1.2% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	+	+	+	Yellowish black
T2	5	Alum	+	+	+	Yellowish black
T3	9	Alum	-	-	-	Yellow blackish red
T4	4	Quick lime	+	+	+	Yellowish red to yellow reddish black
T5	5	Quick lime	+	+	+	Yellow blackish red
T6	9	Quick lime	-	-	-	Yellow blackish red
T7	4	Sodium Acetate	-	+	+	Yellow blackish red
T8	5	Sodium Acetate	-	+	+	Yellow blackish red
T9	9	Sodium Acetate	-	-	-	Yellow blackish red

[+] = High + = medium - = low

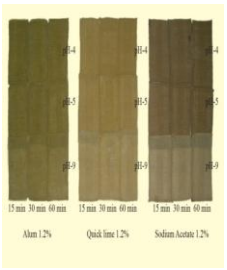


Fig. (5) Colour pattern of dye cloths with crude dye solution extracted from Banda leaves

Colouration from Banda leaves

The first experiment began with the dye liquid extracted from leaves by using 0.2%, mordants and observed that dyed clothes give the fundamental colour tones of yellowish black and yellowish red. The high fastness properties was recorded in acidic pH 4.0 and 5.0 when alum as well as quick lime was used as mordant (Table 1). In the second experiment in which 0.4% of mordant were applied, similar trend of yellowish black and yellowish red coloration were also recorded as in the cases of first experiment. But no high fastness was observed in this experiment and only medium fastness was founded (Table 2). Similarly, the same pattern of coloration was obtained in the third experiment with very few medium fastness (Table 3).

Table (4) Fastness Properties of Banda Fruits Treated with 0.2% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	3	Alum	+	+	+	Yellowish red
T2	4	Alum	+	+	+	Yellowish red
T3	9	Alum	-	+	+	Yellowish red
T4	3	Quick lime	[+]	[+]	[+]	Yellowish red
T5	4	Quick lime	[+]	[+]	[+]	Yellowish red
T6	9	Quick lime	-	+	+	Yellowish red
T7	3	Sodium Acetate	-	-	-	Dark yellowish red
T8	4	Sodium Acetate	-	-	-	Dark yellowish red
T9	9	Sodium Acetate	-	-	-	Pale yellowish red

[+] = High + = Medium - = Low

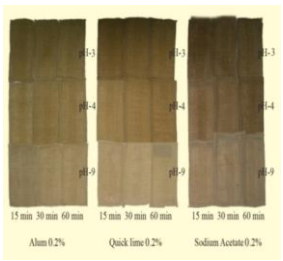


Fig. (6) Colour pattern of dye cloths with crude dye solution extracted from Banda Fruits

Table (5) Fastness Properties of Banda Fruits Treated with 0.4% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	3	Alum	+	+	+	Dark yellowish red
T2	4	Alum	+	+	+	Dark yellowish red
T3	9	Alum	-	+	+	Dark yellowish red
T4	3	Quick lime	[+]	[+]	[+]	Yellowish red
T5	4	Quick lime	[+]	[+]	[+]	Yellowish red
T6	9	Quick lime	-	+	+	Pale yellowish red
T7	3	Sodium Acetate	-	-	-	Yellowish red
T8	4	Sodium Acetate	-	-	-	Yellowish red
T9	9	Sodium Acetate	-	-	-	Pale yellowish red to yellowish red

[+] = High + = Medium - = Low

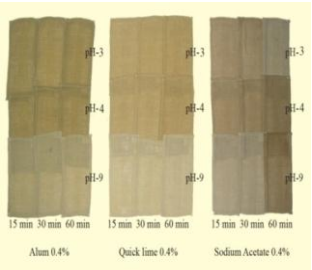


Fig. (7) Colour pattern of dye cloths with crude dye solution extracted from Banda Fruits

Table (6) Fastness Properties of Banda Fruits Treated with 1.2% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	3	Alum	+	+	+	Yellowish red
T2	4	Alum	+	+	+	Yellowish red
T3	9	Alum	+	+	+	Pale yellowish red
T4	3	Quick lime	[+]	[+]	[+]	Bright yellowish red
T5	4	Quick lime	[+]	[+]	[+]	Bright yellowish red
T6	9	Quick lime	+	+	+	Bright yellowish red
T7	3	Sodium Acetate	-	-	-	Dark yellowish red
T8	4	Sodium Acetate	-	-	-	Dark yellowish red
T9	9	Sodium Acetate	-	-	-	Pale yellowish red

[+] = High + = medium - = low

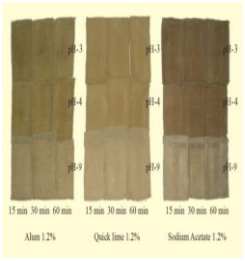


Fig. (8) Colour pattern of dye cloths with crude dye solution

The first experiment used the dye liquid extracted from fruit of banda by using the same mordants concentration and the pH levels of 3.0, 4.0 and 9.0 as mentioned in these case of leaves. It was noticed that major pattern of colouration was yellowish red but the high fastness properties was provided by 0.2% quick lime at acidic pH (Table 4). The second experiment with 0.4% mordant showed the same pattern of color tones as in first experiment (Table 5). In the third experiment 1.2% mordant the basal colouration found to be yellowish red and high fastness was recorded with quick lime at acidic pH levels (Table 6).

Table (7) Fastness Properties of Banda Barks Treated with 0.2 % Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	+	+	+	Dark reddish yellow
T2	5	Alum	+	+	+	Dark reddish yellow
T3	9	Alum	-	+	+	Yellowish red
T4	4	Quick lime	[+]	[+]	[+]	Dark reddish yellow
T5	5	Quick lime	[+]	[+]	[+]	Dark reddish yellow
T6	9	Quick lime	-	-	-	Pale yellowish red
T7	4	Sodium Acetate	-	-	-	Dark reddish yellow
T8	5	Sodium Acetate	-	+	-	Dark reddish yellow
T9	9	Sodium Acetate	-	-	-	Pale yellowish red

[+] = High + = Medium - = Low

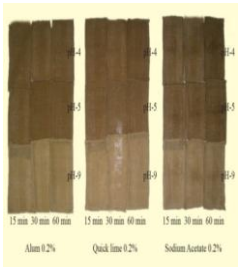


Fig.(9) Colour pattern of dye cloths with crude dye solution extracted from Banda Bark.

Table (8) Fastness Properties of Banda Bark Treated with 0.4% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	+	+	+	Dark yellowish red
T2	5	Alum	+	+	+	Dark yellowish red
T3	9	Alum	-	[+]	+	Dark yellowish red
T4	4	Quick lime	[+]	[+]	[+]	Yellowish red
T5	5	Quick lime	[+]	[+]	[+]	Yellowish red
T6	9	Quick lime	+	+	+	Pale yellowish red
T7	4	Sodium Acetate	-	-	-	Slightly dark yellowish red
T8	5	Sodium Acetate	-	-	-	Slightly dark yellowish red
T9	9	Sodium Acetate	-	-	-	Yellowish red

[+] = High + = Medium - = Low

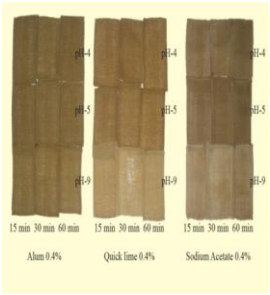


Fig. (10) Colour pattern of dye cloths with crude dye solution extracted from Banda Bark

Table (9) Fastness Properties of Banda Barks Treated with 1.2% Different Mordant

Treatment	pH	Mordant	Duration of Dyeing			Resultant Colour
			15 min	30 min	60 min	
T1	4	Alum	+	+	+	Dark yellowish red
T2	5	Alum	+	+	+	Dark yellowish red
T3	9	Alum	[+]	[+]	+	Slightly pale yellowish red
T4	4	Quick lime	[+]	[+]	[+]	Bright yellowish red
T5	5	Quick lime	[+]	[+]	[+]	Bright yellowish red
T6	9	Quick lime	+	+	+	Pale yellowish red
T7	4	Sodium Acetate	-	-	-	Dark yellowish red
T8	5	Sodium Acetate	+	-	-	Dark yellowish red
T9	9	Sodium Acetate	+	-	-	Pale yellowish red

[+] = High + = medium - = low

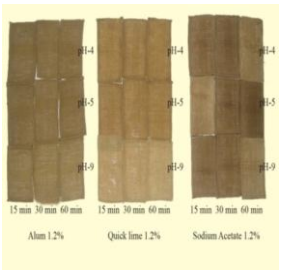


Fig.(11) Colour pattern of dye cloths with crude dye solution extracted from Banda Bark

Colouration from Banda Bark

The first experiment used the dye liquid extracted from bark of banda barks by using the same mordants concentration and the pH levels of explained in the case of fruits. It was observed that major pattern of colouration was reddish yellow and yellowish red all dye clothes with three different mordants levels. But high fastness was chiefly resulted with quick lime at acidic pH levels (Table 7). Similar tone of results was found in second experiment using 0.4% mordant at similar pH levels as in the first experiment. The basal colouration was yellowish red and high fastness was visualized in the quick lime at acidic pH levels (Table 8). In the third set of experiment in which 1.2% mordants were used the basal colour tones was found to be yellowish red. When 1.2% alum was applied in dyeing process pale yellowish red was observed in the alkaline pH with high fastness. It was altered to bright yellowish red if the mordant changed to quick lime at acidic pH levels (Table 9).

Results

There are almost no hazardous chemicals in the cloth dyed with naturally extracted plant pigments. Red listed dangerous chemical mordant may be either avoided or may be optimized as per eco-standard, without damaging the desirable properties (e.g. Fastness) of the textiles. Banda tree are easily found in the local region. Leaves fall twice in a year, these can be collected and used for dyeing variety of colours on cotton very effectively .Similarity, barks and fruits can also be collected easily and extracted. The plant dyes from Banda are impressively utilized in dyeing clothes pieces. Different shades on fabrics with good to excellent fastness properties have been obtained. After extraction of dye from plant parts of *Terminalia cattapa* L. Remaining organic matter can be used as fertilizer and after dyeing process all the liquid matter can be used in fish breeding. So the process of dyeing is totally eco-friendly. The present investigation deals with the waste utilization of the natural resources.

The commercialization of the present process will be helpful for their viable application in handloom and textile industries. Furthermore, this will have great impact especially on the economic growth of the rural dyer communities. Plants are vital part of the environment and they play an important role in every sector of human welfare such as food, feed, shelter, health, decoration and pleasant feeling of mind and body. Historical record with colours reflected the importance of dye plants in old days. In some plants,the parts used were cut into pieces or pounded and dipped into limited amount of water before extraction by boiling .In the present work, all the present plant resources and their parts are used to extract dye according to Japanese method (2000) with slight modification and also with official methods applied in the Saunder's Weaving Institute Amarapura Township, Mandalay Division.

These methods were based on decoction or boiling water methods and its can also be termed as Myanmar traditional dyeing methods. In the present works, the results were in accord with the results of above scientists the pH of original crude dyed liquid was measured and divided into three parts and different pHs of the original were further adjusted depending on plant types and original pHs. All three types of crude dye liquid in different pHs were applied in the dyeing of white cloths the variety of colour tones were visualized as expected according to above mentioned literatures. Since 19thcentury, there were enormous amount of literature concerned the extraction of dyed and the fundamental methods of extraction decoction using mostly water.

In the present work, chemical mordants such as alum, quick lime and sodium acetate, etc. were variously applied in dyeing processes so as to visualize the variety of colour tones. In the present work, altogether leaves, fruits and bark of *Terminalia catappa* L. (banda) plants were used in the investigation of dyeing the cloth and fundamental parameter for simple dyeing was evaluated. After the extraction of crude dye liquid three different level of pHs were also done and subjected in the dyeing of clothes using various mordants. In one run of experiments, 81 pieces of clothes in 14 x 11 cm were used in dyeing process of one resource plant. According to Hancock (1997) it was recognized that all parts of the plants might provide a dye but even the same plant species could give different colours and intensity because of the nature of part used, age, locality, conditions for growth and duration of the year. According to Akiyama (1992) and Yamazaki (2000) and colouration of clothes was altered according to change of natural as well as chemical mordants. In 1983. Franky reported that plant pigment can provide different color according to the change of pH.

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