STUDY ON THE SORPTION OF NATURAL DYES EXTRACTED FROM *ACACIA AURICULIFORMIS* A.CUNN. (MALAY-SHA-PADAUK) BARK ON COTTON AND ITS ANTIMICROBIAL ACTIVITIES

Zin Mar Win[1], Hmwe Nantthar[2], Nwe Nwe Aung[3]

Abstract

In this research work, the bark of *Acacia auriculiformis* A.cunn (malay-sha-padauk) was collected from Pyay Township, Bago Region. Physicochemical parameters of the raw bark powder such as moisture content, ash content, bulk density and pH content were determined. Natural dyes were extracted from the bark of malay-sha-padauk by different solvents (water, ethanol and methanol). The prepared natural dyes were characterized by FT IR, EDXRF and UV-Visible analyses. Relative abundances of elements in the extracted dye were analyzed by EDXRF which showed the chemical constituents of the element. The phytochemical tests of extracted natural dye were carried out. Furthermore, the antimicrobial activities of malay-sha-padauk dye were investigated by Agar Disc Diffusion method on six tested organisms. The maximum wavelength (λ_{max}) of dyes extracted with water, ethanol and methanol were 490 nm**,** 489 nm and 497 nm, respectively. Sorption properties of 1000 ppm natural dye solutions dyeing on cotton were studied at different temperatures (40, 50, 60, 70 and 80 °C) and contact time and pH (3, 4, 5, 6, 7 and 8) by UV-Visible spectrophotometer at different wavelengths for the various extract of malay-sha-padauk bark. From the experiment, it was revealed that the optimum temperature of dyes were at 70 °C and the optimum condition of dyeing on cotton were contact time of 50 min and pH 6. At optimum conditions, natural dye solutions with different alum dosages dyeing on cotton were studied by using UV-Visible spectrophotometer and more effective mordant (alum) dosage of 0.1 g was achieved for the dyeing process. The dye sample solutions were prepared by mixing natural dye powder with alum, onion peel, jengkol peel and tea waste to improve colour strength of dyes. Natural dye solutions dyeing on cotton were studied under optimum conditions by using three mordanting methods (pre-mordanting, simultaneously mordanting and post-mordanting).The colour intensities of these dyeing cotton was determined by Reflection Transmission Color Densitometer.

Keywords: Natural dye, *Acacia auriculiformis* A.cunn. , Malay-sha-padauk bark, antimicrobial activities, mordants

Introduction

Nature provides a wealth of plants which will yield their colour for the purpose of dyeing, many natural dyes have been used since antiquity. Natural dyes are known for their use in colouring of food substrate, leather as well as natural protein fibers like wool, silk and cotton as major areas of application since pre-historic times. Natural dyes are those obtained from plants, animals and minerals. Most of the natural dyes are found to be non-carcinogenic in nature. The use of non-allergic, non-toxic and eco-friendly natural dyes on textiles have become a matter of significant importance due to the increased environmental awareness in order to avoid some hazardous synthetic dyes (Alam, 2004).

Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes are widely available at an economical price and produce

[1] Assistant Lecturer, Department of Chemistry, Pyay University
PhD Candidate, Department of Chemistry, University of Yangon
[2] Dr, Lecturer, Department of Chemistry, Pyay University
[3] Dr, Lecturer,Department of Chemistry, University of Yangon

a wide variety of colours; these dyes, however, produce skin allergy, toxic wastes and other harmfulness to human body. For successful commercial use of natural dyes, the appropriate and standardized dyeing techniques need to be adopted without scarifying required quality of dyed textiles materials.

Aqueous extraction of natural dyes was most preferred method by textile dyers. The standardized dyeing techniques are needed for the better commercialization of natural dyes. Natural dyes have less substantivity to the fiber and have poor fastness properties, hence requires a mordant to improve their fixation in the fiber by forming a mordant- dye complex through chemical bonds. Mordants are metal salts which produce affinity between dye and the fiber. Mordants not only help in dye uptake and colour fastness, it also helps in achieving different colour shades in the textiles (Samanta and Agarwal, 2009). Biomordants are onion peel, jengkol peel and tea waste. Tannin is a widely used as biomordant. Tannin was used for dyeing and printing by people from onion peel, jengkol peel and tea waste.

The need to identify active chemical constituents in the plant extract required phytochemical and analytical techniques. Phytochemical surveys are being seen as the first step towards the discovery and structural elucidation of useful natural organic constituents for textile or medicinal applications. Many plants are chemically very variable depending on the locality where they are found with some of the constituents occurring only of certain seasons of the year (Adelani, 2007).

Moreover, natural dyes have positive effect on antifungal and antibacterial growth. Natural dyes not only release medicinal properties but also improve the aesthetic value of the product and they are unique and ecofriendly. Many of the plants used for dye extraction are classified as medicinal and some of these have recently been shown to possess remarkable antimicrobial activity (Machado *et al*., 2003). Many other common natural dyes are reported as potent antimicrobial agents owing to the presence of a large amount of tannins (Hussein *et al*.,1997).

Materials and Methods

Sample Collection

Acacia auriculiformis A.Cunn. is the plant used in this study for extraction of dye, which was collected from Pyay Township, Bago Region. The part used for the dye extraction was only bark.

Collection of Cotton

Cotton was purchased from Shwetaung Myoema Market, Bago Region.

Pretreatment of Cotton

The degummed cotton was soaked in mixture of 1 g L^{-1} of sodium carbonate and 2.5 g $L^{-1}$of detergent at 80°C for 30 min and then washed with running tap water to remove the natural impurities and improve the texture of cotton for dyeing.

Extraction of Tannin

The raw tea waste, onion peel and jengkol peel (10g each) were extracted with distilled water (1L) and the setup was kept boiling for 60 min.The extracted tannin was filtered and was used for mordanting.

Mordanting

Tannin extracted from tea waste,onion peel and jengkol peel has been used as biomordants to avoid toxicity caused by harmful chemical mordants. Extraction method has been standardized for maximum yield of tannin.

Utilization of Biomordants in Dyeing Method

Biomordants (tea waste, onion peel and jengkol peel) were utilized with different concentrations (10 %,20 %,30 %) for 1 h for mordanting with cotton cloth.The optimum concentration for each biomordant was selected and then dyeing method; pre-mordanting, simultaneous mordanting and post-mordanting were carried out.

Extraction of Dyes with different solvents

Aired dried powder of malay-sha-padauk bark (10 g) was extracted with each 100 ml of solvents (water, ethanol and methanol) in sonicator for 3 times each 30 mins and filtered. The filtrates were evaporated by distillation at various temperature (100,78,65) °C respectively. And then, they were dried in oven and were crushed in motar and pestle for semi-dried solid mass and sieved with 90 μm aperture size. Finally, dye powders of water extract, ethanol extract and methanol extract were 49.6%, 40.8%, 44.7% respectively.

Optimization of Dyeing

The pretreated cotton was dyed using dyes extracted (water,ethanol and methanol) from malay-sha padauk.Optimization of dyeing of cotton were studied at different temperature (40, 50, 60, 70 and 80 °C) and contact time (20,30,40,50,60,70 and 80)mins and pH (3, 4, 5, 6, 7 and 8) by using UV-Visible spectrophotometer.The optimum temperature, contact time and pH of water,ethanol and methanol dyes extracted were selected. And then,the most suitable conditions for dyeing on cotton was selected.

Dyeing procedure

The pretreated cotton was dyed using selected water extracted dye from malay-sha padauk bark and selected 20 % of biomordant (tea waste), 30 % of biomordants (onion peel and jengkol peel) at the optimum temperature 70°C, contact time 50min and pH 6 by using pre-mordanting, simultaneous mordanting and post- mordanting methods.

Determination of colour density

The colour density of the dyed cotton before and after lighting and washing were determined by Reflection Transmission Colour Densitometer at Universities' Research Center, Yangon.

Determination of Physicochemical Properties and Characterization of Dyes

Physicochemical Properties

Malay-sha padauk bark powder were washed with water to remove the adhering dirt and impurities. They were dried at room temperature and weighed. The physicochemical characteristics of malay-sha padauk bark powder such as moisture content, ash content, bulk density were determined by AOAC method and pH was determined by pH meter.

Phytochemical Investigation of Malay-sha padauk dye

Phytochemical investigation of malay-sha padauk dye was performed to determine the presence or absence of phytochemical compounds according to the methods and procedures expressed in the Phytochemical Bulletin of Botanical Society of America (Harborne, 1998).

UV-Visible Spectroscopy

The dye extracts were analyzed in UV-Visible spectrophotometer at the range of 400-800 nm ,to determine the wavelength of maximum absorption (λ_{max}) of the dye pigments.

FT IR Spectroscopy

FT IR measurements were carried out to determine the functional group of natural dye extracted from malay-sha-padauk. All measurements were carried out in the range of 400 -4000 cm^{-1}.The dye samples were measured by using Prekin Elmer GX system, FT IR spectrophotometer

EDXRF Spectroscopy

Elemental compositions in extracted dye from malay-sha-padauk by using solvents such as water and ethanol were determined by EDXRF spectrometer (Shimadzu Co.Ltd.,Japan).

Determination of the Antimicrobial Activities

The extracted dye solution were tested with *Aspergillus flavous, Bacillus subtilis, Candida albicans, Pseudomonas fluorescens , Xanthomonas oryzae* and *Escherichia coli* species to investigate the nature of antimicrobial activities by Agar Disc Diffusion Method.

Adsorption Capacity

The adsorption capacity of dyes was calculated using an equation on the basis of absorbance values recorded before and after dyeing with UV-Visible spectrophotometer.

$$\mathbf{q_t(mg\ g^{-1}) = \frac{C_o - C_e(mg\ L^{-1})}{Unit\ mass\ of\ adsorbent(g)} \times Volume\ of\ Solution\ (L)}$$

where,

q_t = adsorption capacity (mg g^{-1})
C_o=Initial concentration (mg L^{-1})
C_e=equilibrium concentration (mg L^{-1})
unit mass of adsorbent = 1g
Volume of solution = 0.1 L

Results and Discussion

The physicochemical characteristics of malay-sha-padauk bark powder and phytochemical investigation of water extracted dye sample were determined. Table 1 indicates that the results of 16.34 %w/w moisture content, 3.97 %w/w ash content and 0.98 gcm^{-3} bulk density in raw sample were observed. pH of the extract was 6.8. According to the results of physicochemical analysis, it was found that alkaloids, steroids, terpenoidsgly, flavonoids, cosides, phenolic compounds, tannins, α-amino acids, saponins, and cyanogenic glycosides were present in malay-sha-padauk dye sample whereas carbohydrates, starch and reducing sugar were absent in this extracted dye sample.

Table 1 Physicochemical Properties of Malay-sha-padauk Bark Powder

No	Characteristics	MLS
1	Moisture content (%)	16.34
2	Ash content (%)	3.97
3	Bulk density (g cm^{-3})	0.98
4	pH	6.8

Characterization of Malay-sha-padauk Dyes

Relative abundances of elements present in water and ethanol extracted dyes from malay-sha-padauk were determined by EDXRF analysis. According to EDXRF spectrum, water extract dye sample contained calcium 35.05 %, iron 28.74 %,potassium 26.31 %, silicon 4.97 %, sulphur 1.96 %,titanium 0.87 % and manganese 1.19 %. Ethanol extract dye sample contained calcium 66.46 %,iron 12.64 %, potassium 12.37 %,silicon 3.57 %,sulphur 2.64 %, titanium 1.48 % and copper 0.53 % (Figures 1 and 2 and Table 2).

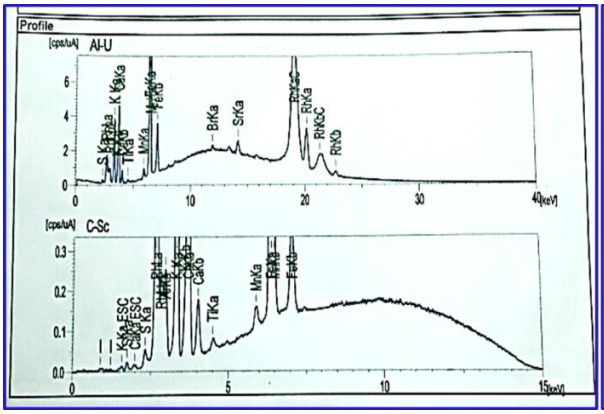


Figure 1 EDXRF spectrum of water extracted dye from bark of malay-sha-padauk

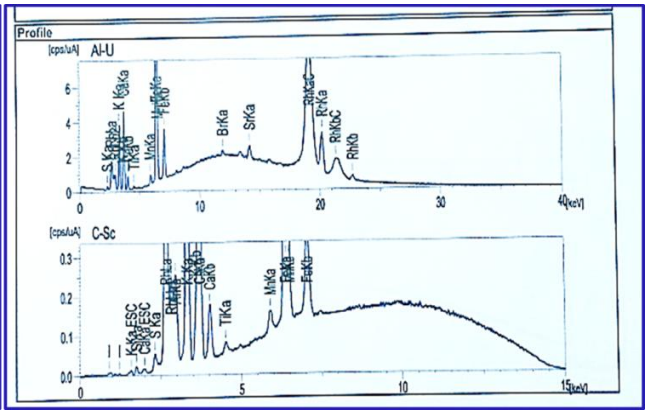


Figure 2 EDXRF spectrum of ethanol extracted dye from bark of malay-sha-padauk

Table 2 Relative Abundance of Element present in Water and Ethanol Extracted Dyes of *A.auriculiformis* (Malay-sha-padauk)

Element	Relative Abundance (%)	
	Water Extract	Ethanol Extract
Ca	35.05	66.46
Fe	28.74	12.64
K	26.31	12.37
Si	4.97	3.57
S	1.96	2.64
Ti	0.87	1.48
Mn	1.19	-
Cu	-	0.53

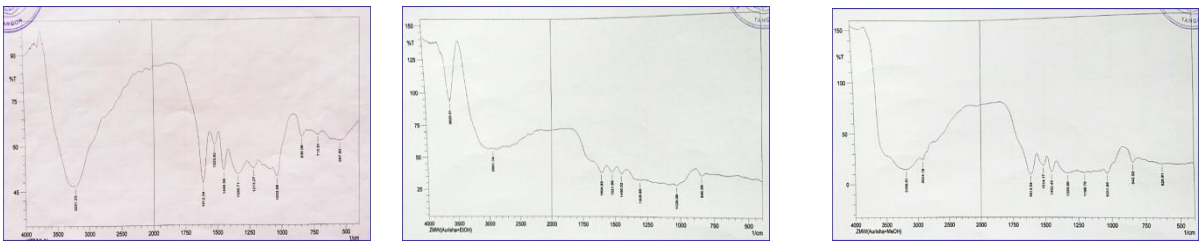
UV-Visible Analysis

The wavelengths of maximum absorption (λ_{max}) of extracted dyes were found to be 490 nm for water, 489 nm for ethanol and 497 nm for methanol extracts by using UV-Visible spectrophtometer.

FT IR Analysis

Figures (3)(a)(b) and (c) show that FT IR spectra of natural dye extracted from *A. auriculiformis* (malay-sha-padauk) with different solvents (water,ethanol and methanol).The characteristic absorption bands at 3221 cm^{-1},1612 cm^{-1},1523 cm^{-1} and 1033 cm^{-1} were observed.These peaks correspond to groups present in the sample and appeared due to

O-H stretching,C=O stretching,C=C aromatic stretching, and C-O-C stretching which is the good correlation with that of literature.These bands confirmed the presence of terpenoids, flavonoids and tannin in natural dyes (Table 3).



(a) (b) (c)

Figure 3 FT IR spectra of natural dyes extracted from *A.auriculiformis* (malay-sha- padauk) with different solvents

Table 3 Absorption Bands Assignments of Malay-sha-padauk Dye Extracted with Water, Ethanol and Methanol

Observed Frequency (cm^{-1})			Literature frequency* (cm^{-1})	Band assignments
MLS-W	MLS-EtOH	MLS-MeOH		
3221.23	3620.51	3210.51	3650 - 3200	O-H stretching
-	2951.19	2924.18	3000-2800	C-H stretching
1612.54	1604.83	1612.54	1700-1600	C=O stretching
1523.82	1521.89	1514.17	1550-1510	C=C aromatic stretching
1448.59	1450.52	1452.45	1465-1440	C-H bending(CH_3)
1213.27	-	1199.76	1280-1150	C-O stretching
1033.88	1028.09	1031.95	1070-1020	C-O-C stretching
839.06	840.99	842.92	900-800	=CH bending
715.61	-	-	800-700	N-H wagging

*** (**Silverstein *et al*., 2003)

Antimicrobial Activities of Malay-sha-padauk Dye

Screening of the antimicrobial activities of ethyl acetate, acetone, chloroform, ethanol, methanol, pet- ether and water extract was tested on six tested organisms such as *Aspergillus flavous, Bacillus subtilis, Candida albicans, Escherichia coli, Pseudomonas fluorescens, Xanthomonas oryzae* by Agar Disc Diffusion method. Among them, petroleum ether extract showed higher activity on five types of microorganism such as *Aspergillus flavous, Bacillus subtilis, Candida albicans, Escherichia coli* and *Pseudomonas fluorescens except Xanthomonas oryzae* and watery extracts showed no activity on all tested microorganism. In addition, malay-sha-padauk dye extract with pet-ether shows more significant zone of inhibition on five tested microorganisms when compared with other extracts. Therefore,it was found that antimicrobial activity of pet-ether extract was found to be more potent than other extracts as shown in Figure 4 and Table 4.

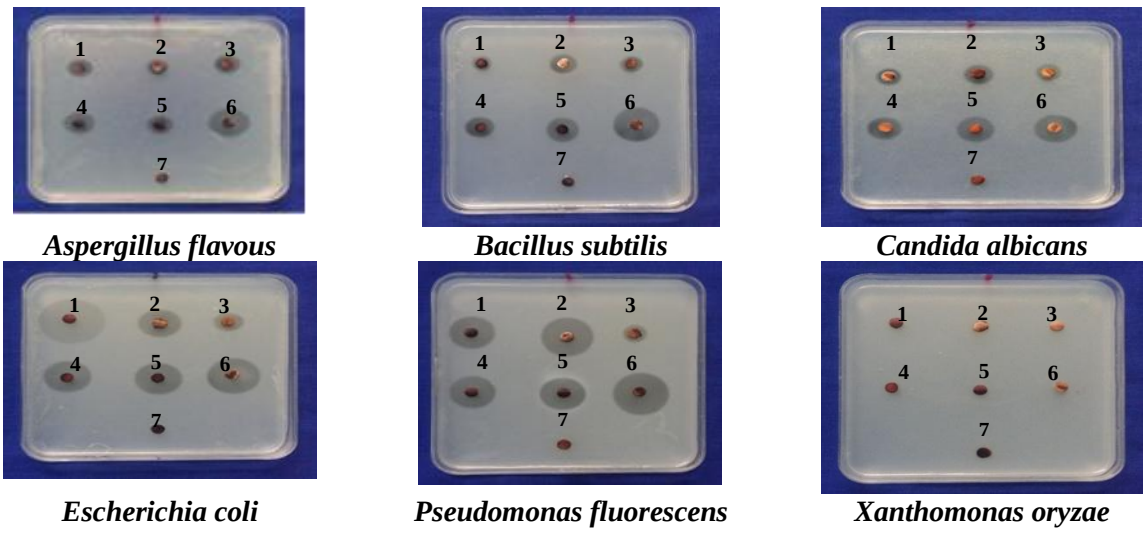


Figure 4 Antimicrobial activities of various solvent extracts of malay-sha-padauk dye

Table. 4 Antimicrobial Activities of Malay-sha-padauk Dye

No	Test Organisms	Acetone	$CHCl_3$	EtoAc	EtOH	MeOH	Pet. ether	H_2O
		Inhibition Zone Diameters (mm)						
1.	*Aspergillus flavous*	12(++)	10(+)	12(++)	15(++)	14(++)	23(+++)	-
2.	*Bacillus subtilis*	8(+)	12(++)	10(+)	14(++)	16(++)	20(+++)	-
3.	*Candida albicans*	10(+)	14(++)	8(+)	14(++)	15(++)	28(+++)	-
4.	*Escherichia coli*	23(+++)	18(+++)	12(++)	16(+++)	20(+++)	23(+++)	-
5.	*Pseudomonas fluorescens*	20(+++)	22(+++)	10(+)	18(+++)	20(+++)	23(+++)	-
6.	*Xanthomonas oryzae*	-	-	-	-	-	-	-

Agar well - 6 mm, 6 mm ~ 10mm (+), 11mm ~ 15mm (++), 16 mm above (+++), No activity (-)

Sorption of Extracted Dye from Malay-sha-padauk on CottonEffect of temperature

Batch adsorption experiments were conducted by 1 g of cotton to 100 mL of dye solutions with water in 250 mL beaker. A 100 mL dye solution contain in a 250 mL beaker was put in water bath. Natural dye solution dyeing on cotton were allowed to equilibrium for 60 minutes in a water bath at 40, 50, 60, 70 and 80°C. At 10 min intervals, the dye solution was taken from the beaker. The remaining concentration was determined by UV-Visible spectrophotometer at λ_{max} of water extract dye (490 nm). The result are shown in Table 5 and Figure 5. Similarly, sorption properties of ethanol and methanol were also determined at 40, 50, 60, 70 and 80°C by UV-Visible spectrophotometer at λ_{max} 489 nm and 497 nm, respectively. In dyeing, the optimum temperature of extracted natural dyes on cotton was 70 °C.

Table 5 Effect of Temperature on Dyeing with Extracted Malay-sha-padauk Dye on Cotton

Temperature (°C)	q_t (mg/g)		
	water	methanol	ethanol
40	55.39	36.11	59.39
50	66.18	54.17	62.09
60	74.09	60.19	63.72
70	86.39	80.09	77.61
80	64.03	75.07	71.52

q_t = amount of adsorbate per mass of adsorbent
Dose=1.0 g in 1000 mL of sample solution, time= 1 h

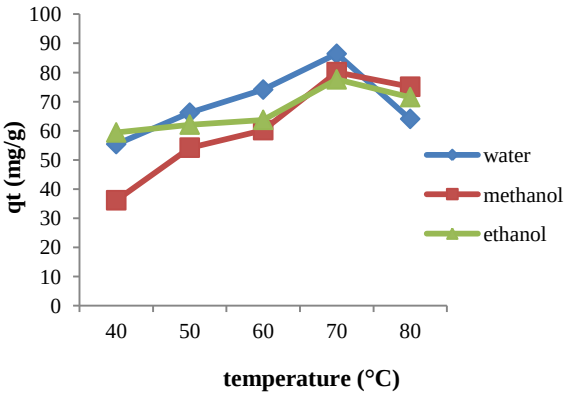


Figure 5 Effect of temperature on dyeing with the extracted malay-sha-padauk bark on cotton

Effect of contact time

Studies on the effect of contact time on dyeing of extracted dye on cotton were conducted by the same procedure for an equilibrium over a range of contact time (20, 30, 40, 50, 60 and 70) min in 250 mL beaker with a temperature control of 70°C. The results are illustrated in Table 6 and Figure 6. It was found that maximum sorption capacities were reached at contact time 50 min.

Table 6 Effect of Contact Time on Dyeing with the Extracted Malay-sha-padauk Bark Dye on Cotton

Time (min)	q_t (mg/g)		
	water	methanol	ethanol
20	48.34	26.85	39.43
30	52.66	33.79	43.16
40	63.38	35.65	54.97
50	77.69	46.77	71.09
60	73.98	42.46	69.03
70	72.45	45.64	62.76
80	69.59	41.67	58.83

q_t = amount of adsorbate per mass of adsorbent
Dose=1.0 g in 1000 mL of sample solution, 70°C

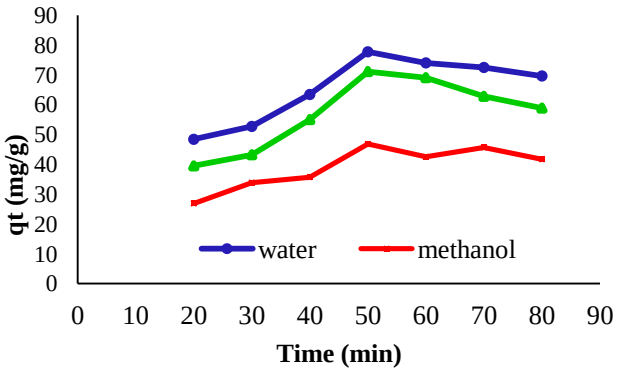


Figure 6 Effect of contact time on dyeing of extracted malay-sha-padauk bark on cotton

Effect of pH

Studies on the effect of pH on dyeing of extracted dye on cotton were conducted by the same procedure for an equilibrium over a range of pH values of 3, 4, 5, 6, 7 and 8 which pH were adjusted with 1% HCl and 1% NaOH .The extracted dyes were dyed on cotton allow to equilibrate for 50 mins in a water bath at 70 °C. The results are illustrated in Table 7 and Figure 7. In dyeing on cotton, the optimum pH of extracted natural dyes was 6.

Table 7 Effect of pH for on Dyeing with the Extracted Malay-sha-padauk Bark Dye on Cotton

pH	q_t (mg/g)		
	water	methanol	ethanol
3	72.68	59.39	66.68
4	80.18	62.09	73.22
5	85.89	66.34	78.89
6	93.76	81.41	88.75
7	89.91	77.61	82.91
8	71.33	79.87	75.34

q_t = amount of adsorbate per mass of adsorbent
Dose=1.0 g in 1000 mL of sample solution, 70 °C , 50 min

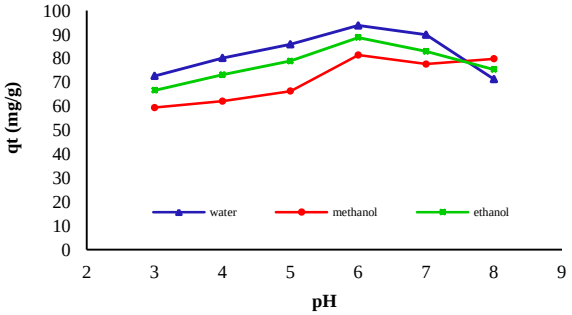


Figure7 Effect of pH on dyeing of extracted malay- sha- padauk bark on cotton

Effect of Mordant (Alum) Dosage

At the dye concentration 1000 ppm,contact time 50 min and temperature 70 °C studies on the effect of mordant (alum) dosage on dyeing of extracted dye on cotton were conducted by the same procedure for an equilibrium over a range of alum dosage (0.00625, 0.0125, 0.025, 0.05, 0.075, 0.1, 0.125 and 0,15)g by using UV-Visible spectrophotometer. Among the different alum dosage, 0.1g of alum dosage was the effective sorption capacity for dyeing process. The result was illustrated in Table 8 and Figure 8.

Table 8. Effect of Alum Dosage on Dyeing of Malay-sha-padauk bark on Cotton

Alum Dosage(g)	q_t (mg/g)		
	water	methanol	ethanol
0.00625	45.32	36.01	37.46
0.0125	54.12	41.61	55.34
0.025	70.12	60.11	65.98
0.05	79.53	72.11	74.28
0.075	81.68	72.78	76.54
0.1	93.41	82.21	86.73
0.125	80.02	79.55	65.19
0.15	74.28	73.19	56.04

q_t= amount of adsorbate per unit mass of adsorbent
Dose=1.0g in 1000 mL of sample solution, 70°C ,50 min

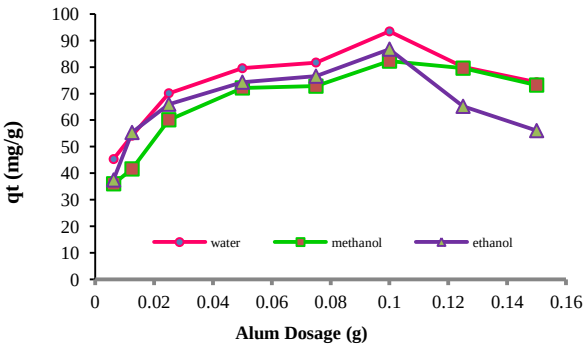


Figure 8 Effect of alum dosage on dyeing of extracted malay-sha-padauk bark on cotton

Colour Fastness Properties of five Dye Solutions Dyeing on Cotton

In this research, biomordants (onion peel, jengkol peel and tea waste) and chemical mordant (alum) were studied for dyeing process.The colour density on the cotton was increased significantly by using mordant.For dyeing process, colour fastness of cotton samples were prepared using pre-mordanting, simultaneous mordanting and post-mordanting. The colour

density for five dyeing cotton cloth before and after colour fastness testing were compared in Tables 9 (a)(b)(c)and(d) and Figures 9 (a)(b)(c)and (d). Desorption properties for post-mordanting are shown in Table 10.

In dyeing, poor substantivity and fastness properties are often found in natural dyes for cotton and can be improved if the cotton was first treated with a solution containing mordant, such as a salt of alum. Metallic mordant and biomordants improve the fixation and fastness properties of dyes lacking substantivity for cotton.

The colour fastness results of five dyeing cotton in pre-mordanting, simultaneous mordanting and post-mordanting are shown in Table 9 a. The sample S_1 (natural dye) was seen the lowest colour density.The sample S_5 (tea waste biomordant) was medium colour density and S_4 (jengkol peel biomordant) was the highest colour density. The sample S_2(alum) and S_3 (onion peel biomordant) were nearly equal colour density.Therefore, biomordant (onion peel) can be used instead of chemical mordant (alum) for malay-sha-padauk dye solution (Li *et al*., 2016).

According to the desorption properties, S_4 (jengkol peel biomordant) was good colour fastness biomordant among the five mordants such as S_1 S_2 S_3 S_4 and S_5.So,it can be applied in home-made dyeing process. The results were shown in Table (10).

Table 9(a) Colour Density of Cotton Dyed with Water Extract of Malay-sha- padauk Dye

Type of Mordants	**Colour Density /**				
mordanting	Without S_1	Alum S_2	Onion peel S_3	Jengkol Peel S_4	Tea waste S_5
Pre-mordanting	0.38	0.41	0.44	0.73	0.61
Simultaneous mordanting	0.38	0.43	0.43	0.86	0.74
Post mordanting	0.38	0.48	0.52	0.90	0.79

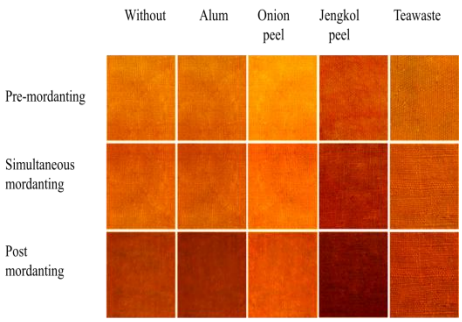


Figure 9(a) Colour density of cotton dyed with water extract of malay-sha padauk dye

Table 9 (b) Variations in Colour Density of Cotton Dyed AfteFastnesTest(Pre-modanting with water extract of Malay-sha padauk Dye)

	Colour Density / Mordants				
Mordant	**Without** S_1	**Alum** S_2	**Onion peel** S_3	**Jengkol peel** S_4	**Tea waste** S_5
Before	0.38	0.41	0.44	0.73	0.61
lighting	0.33	0.37	0.42	0.71	0.57
Washing	0.31	0.37	0.40	0.56	0.41

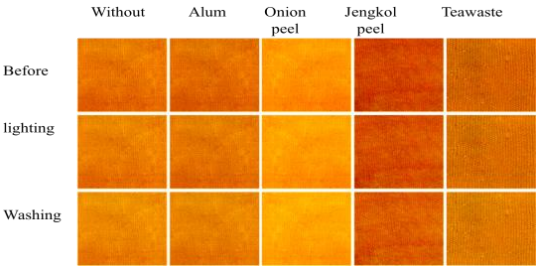


Figure 9(b) Variations in colour density of cotton dyed after fastness test (pre - modanting with water extract of malay-sha padauk dye)

Table 9 (c) Variations in Colour Density of Cotton Dyed After Fastness Test (Simultaneous modanting with water extract of Malay-sha padauk Dye)

	Colour Density / Mordants				
Mordant	**Without** S_1	**Alum** S_2	**Onion Peel** S_3	**Jengkol Peel** S_4	**Tea waste** S_5
Before	0.38	0.43	0.43	0.86	0.74
lighting	0.37	0.41	0.43	0.72	0.73
Washing	0.36	0.40	0.41	0.65	0.55

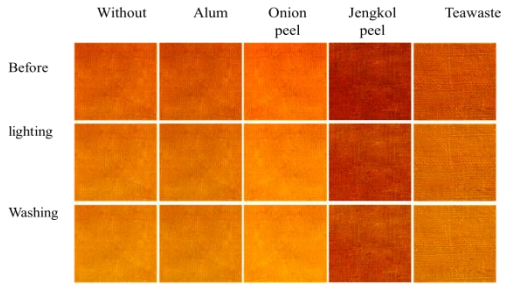


Figure 9(c) Variations in colour density of cotton dyed after fastness test (simultaneous modanting with water extract of malay-sha padauk dye)

Table 9 (d) Variations in Colour Density of Cotton Dyed After Fastness Test (Post-modanting with water extract of Malay-sha padauk Dye)

	Colour Density / Mordants				
Mordant	Without S_1	Alum S_2	Onion peel S_3	Jengkol Peel S_4	Tea waste S_5
Before	0.38	0.48	0.52	0.90	0.79
lighting	0.36	0.47	0.50	0.90	0.76
Washing	0.36	0.46	0.49	0.89	0.77

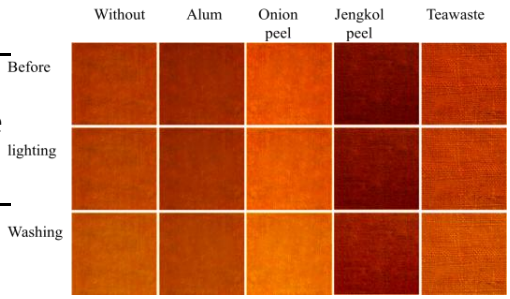


Figure9 (d) Variations in colour density of cotton dyed after fastness test (post-modanting with water extract of malay-sha padauk dye)

Table 10 Difference Before and After Wash Fastness (Post-Mordanting) Properties of Five Dye Solutions on Cotton

	Without	Alum	Onion peel	Jengkol Peel	Tea waste
	S_1	S_2	S_3	S_4	S_5
Desorption values	0.02	0.02	0.03	0.01	0.02

Conclusion

In this research work, an eco-friendly dye from natural source and dyeing on cotton with biomordants. The physicochemical parameters of bark of malay-sha-padauk such as moisture content 16.34 %, ash content 3.97 %, bulk density 0.98 gcm^{-1} and pH 6.8 were observed. The preliminary phytochemical screening tests of bark dye showed the presence of alkaloids, steroids, terpenoids, flavonoids, glycosides, phenolic compounds, tannins, α-amino acids, saponins, and cyanogenic glycosides whereas carbohydrates, starch and reducing sugar were absent in this extracted dye sample. By the determination of UV-Visible spectra, the maximum absorption peak of water, ethanol and methanol extracted natural dyes were appeared to 490 nm, 489 nm and 497 nm respectively. FT IR spectrum of extracted natural dyes indicated that the intensity band at 3221 cm^{-1} is corresponding to OH stretching,1612 cm^{-1} is C=O stretching, 1523 cm^{-1} is due to C=C aromatic stretching and 1033 is corresponding to C-O-C stretching. According to EDXRF spectra, the relative abundance of element present in water and ethanol extracted of natural dye were 35.05 % and 66.46 % of calcium respectively. From the experimental result, the best dyeing was achieved at pH 6, 70°C for 50mins with dye concentration 1000 ppm for extracted natural dyes by using UV-visible spectrophotometer. Among the various extracted natural dyes, water extracted dye was the most suitable for dyeing on cotton. Among three mordanting methods, post-mordanting method was the best for dyeing process. In this research, biomordants (onion peel, jengkol peel and tea waste) and chemical mordant (alum) were studied for dyeing process. The sample S_1 (natural dye) has the lowest colour density. The sample S_5 (tea waste) was medium colour density and S_4 (jengkol peel) was the highest colour density. The colour density sample S_2 (alum) and S_3 (onion peel) were nearly equal. Therefore, biomardant (onion peel) can be used as instead of chemical mordant (alum) for dye sample solution. According to the desorption properties, S_4 (jengkol peel) was good colour fastness biomordant among the five mordants such as S_1 S_2 S_3 S_4 and S_5. So, it can be applied in home-made dyeing process. Screening of the antimicrobial activities of ethyl acetate, acetone, chloroform, ethanol, methanol, pet- ether and water extract was tested on six tested organisms by Agar Disc Diffusion method. Among them, malay-sha-padauk dye extract with pet-ether shows more significant zone of inhibition on five tested microorganisms when compared with other extracts. Therefore, it was found that antimicrobial activity of pet-ether extract was found to be more potent than other extracts. Many natural dye possess medicinal properties. So, these textile dyed with natural dyes can be very useful in developing clothing for infants, elderly and infirm people to protect them against common infections. Nowadays, there is increasing awareness among people towards natural products.

Acknowledgements

The authors would like to thank the Department of Higher Education, Ministry of Education, Myanmar, for the permission of doing this research and Myanmar Academy of Arts and Sciences allowing the writing of this paper, Professor and Head Dr Daw Myint Myint Than, Department of Chemistry, Pyay University and Professor and Head Dr Daw Ni Ni Than, Department of Chemistry, University of Yangon, for their kind encouragement.

References

Adelani, P.O. (2007). "Synthetic Pathway of 8-Hydroxyl-9,10-Dimethoxyanthracene-2- Aldehyde (Oruwalol)". *European Journal of Scientific Research*, vol.16 (1), pp. 44-54.

Alam. (2004). "Studies of Some Natural Dyes". *Journal of the Chemical Society*, vol. 26 (3), pp. 255-263.

Harborne, J.B. (1998). *Phytochemical Methods, A Guide to Modern Technique of Plant Analysis*. New York; 3rd Ed., Chapman and Hall, pp. 120-160.

Hussein, S.A.M., Barakat, H.H., Merfort, I. and Nawwar, M.A.M.(1997). "Tannins from the Leaves of *Punica granatum". Phytochemistry*, vol.45, pp. 819-823.

Li, Y.V., Malensek, N., Sarkar, A.K. and Xiang, C.(2016). "Colorfastness Properties of Persimmon Dye on Cotton and Wool Fabrics". *Clothing and Textile Research Journal*, vol. 34(3), pp. 223-234.

Machado, T.B., Pinto, A.V., Pinto, M.C.F.R., Leal, I.C.R., Silva, M.G., Amaral, A.C.F., Kuster, R.M. and Netto-dosSantos, K.R. (2003). "In Vitro Activity of Brazilian Medicinal, Plants Naturally Occurring Naphthoquinones and their Analogues,against Methicillin Resistant S*taphylococcus aureus*". *Int. J Antimicrob Agents*, vol. 21, pp. 279-284.

Samanta, A.K. and Agarwal, P . (2009). "Application of Natural Dyes on Textiles". *Indian Journal of Fibre and Textile Research*, vol. 34, pp. 384-399.

Silverstein, R.M., Webster, F.X. and Kiemle, D.J. (2003). *Spectrometric Identification of Organic Compounds.* New York: 7th Edition., John Wiley and Sons Inc.