SORPTION STUDY ON DYEING PROCESS OF NATURAL DYES EXTRACTED FROM *CASUARINA EQUISETIFOLIA* FORST. (KA-BWEE) BARK ON COTTON CLOTH

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Abstract

In this research work, the raw sample barks (Ka-bwee) were collected from Sittwe, Rakhine State. Physicochemical parameters of Ka-bwee raw bark powder such as moisture content, ash content, bulk density and pH were determined. Natural dyes were extracted from the bark of Ka-bwee by different solvents (water, ethanol and methanol).The prepared natural dyes were characterized by FT IR, EDXRF and UV-visible techniques. Relative abundances of elements in prepared natural dyes were analyzed by EDXRF which showed the chemical constituents of the elements. According to the FT IR, in Ka-bwee dyes extracted by different solvents, functional groups of O-H stretching, C=C, C-O (stretching) and benzene ring were observed. The phytochemical tests of dyes extracted with water were carried out. In phytochemical test, tannins, flavonoids, α-amino acids and others were observed in the dye solutions. Furthermore, antimicrobial activities of Ka-bwee dyes were investigated by agar disc diffusion method on six tested organisms. The wavelengths of maximum absorption (λ_{max}) of Ka-bwee dyes extracted with water, ethanol and methanol were observed at 510, 494 and 499 nm respectively. Sorption properties of 1000 ppm natural dye solutions dyeing on cotton were studied at different temperatures (40-90°C) by using UV-visible spectrophotometer. From the experiment, the optimum temperature of Ka-bwee dyes extracted with water, ethanol and methanol were at 80℃. The optimal conditions of dyeing on cotton cloth were observed at concentration of dye solution (1000 ppm), mordant alum dosage 0.1 g, contact time 60 min and pH 6. The dye solutions were prepared by natural dye powder with water. After dyeing on cotton cloth, the poor wash and light fastness of dyed fabrics improved with mordanting. The colour intensities of these dyed cotton were determined by Reflection Transmission Colour Densitometer. Depending on the type of mordant, such as alum, onion peel, teawaste and jengkol peel (natural mordant), colour fastness of the dyeing cotton cloth were studied.

Keywords: Natural dye, Ka-bwee bark, mordants, dyeing process

Introduction

Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. Natural dyes obtained from plants are renewable and sustainable bio-resource products with minimum environmental impact and known since antiquity for their use, not only as ingredients in food and cosmetics but also in textile colouration. Natural dyes are eco-friendly, bio-degradable, less toxic and less algeric as compared to synthetic dyes (Nisar *et.al.*, 2007). Natural dyes are those obtained from plants, animals and minerals. Most of the natural dyes are found to be non-carcinogenic in nature. Dyes are chemical substances used to impact colours to substrates such as cosmetics, foods, drugs, hairs, furs, textiles and polymers (Osabohien and Otutu, 2014).

Nowadays, extraction and application of natural dyes are becoming more popular owing to the growing awareness of environmental problems coupled with the toxicity associated with synthetic dyes (Rajeswari and Arivalagan, 2017).On the other hand, synthetic dyes, which are

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widely available at an economical price and produce a wide variety of colours, sometimes causes skin allergy and other harmfulness to human body, produces toxicity/chemical hazards during its synthesis, releases undesirable/hazardous/toxic chemicals etc. However, dyes commonly used in textile are seldom screened for use as antimicrobial agents for textile finishing (Singh *et al*., 2004).Dyeing of textiles using synthetic dyestuff is characterized by a high impact on the environment, the dyers as well as the end-users (Narayan, 2017). Natural dyes obtained from barks are renewable, traditionally extracted from animal and plant sources for use in coloring food substrate, leather, wood and natural fibres such as silk, cotton and flax from time immemorial.

Furthermore, natural dyes are known to exhibit better biodegradabilit, less toxicity, eco-friendly alternative to synthetic dyes and some dyes also medicinal properties. The major chemical constituents of Ka-bwee barks are elaggic acid, gallic acid, kaemferol and qurcetin and the barks contains astringent and antioxidant properties and also has significant anticancer and anthelminitic potential (Narayanswamy *et al*., 2013). In the present work, the dye from the barks of *casuarina equisetifolia* forst.were prepared and characterized by modern techniques. Physicochemical properties of Ka-bwee bark powder such as moisture content, ash content, bulk density and pH were studied. Functional groups, elements and maximum absorption wavelengths were studied on the prepared natural dyes by FT IR, EDXRF and UV-analysis, respectively. Furthermore, antimicrobial activities of extracted Ka-bwee dye were tested. The colour intensities of this dye on cotton cloth were determined by Reflection Transmission Colour Densitometer. Depending on the type of mordant, such as alum, onion peel, teawaste and jengkol peel (natural mordant), colour fastness of the dyeing on cotton cloth were studied.

Materials and Methods

Sample Collection

Ka-bwee bark is the sample used in this study for extraction of dye, which was collected from the Sittwe, Rakhine state. The part used for the dye extraction was only bark. And then, they were washed with distilled water and dried at room temperature, and made into fine powder.

Cotton cloth was purchased from Shwetaung Myoema Market, Bago Region.

Pretreatment of Cotton Cloth

The cotton cloth was soaked in mixture of 1 g / L of sodium carbonate and 2.5 g / L 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 cloth for dyeing.

Extraction of Tannin

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

Mordanting

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

Mordanting by Using the Extracted Tannin

Bio-mordants (tannin extracted from onion, teawaste and jengkol peel) were applied on the cotton cloth with different concentrations (10 %, 20 %, 30 %) for 1 hr. The optimum concentration for each bio-mordant was selected and then dyeing method; pre-mordanting, simultaneous mordanting and post mordanting were carried out. The pre-mordanting of cotton cloth was done before dyeing. Dyeing and mordanting were carried out simultaneously. Post mordanting was also done after dyeing of cotton cloth.

Extraction of Dyes from Ka-bwee Barks with Different Solvents

The dried bark powder Ka-bwee (10 g) was extracted with 100 mL of each solvent (water, ethanol and methanol) in sonicator for 30 min and filtered. It was repeated for other two times. The filtrates were evaporated by distillation at various temperatures (100,78,65 ℃). And then, they were dried in oven and they were crushed in motar and pestle and sieved with 90 m aperture size. Finally, dye powders of water extract (4.2 g), ethanol extract (3.6 g) and methanol extract (3.2 g) were obtained.

Characterization of the Extracted Dyes

EDXRF spectroscopy

Elemental compositions in the extracted dye from Ka-bwee by using water was determined by EDXRF spectrometer (Shimadzu Co. Ltd., Japan).

FT IR spectroscopy

FT IR measurements were carried out to determine the functional group of natural dye extracted from Ka-bwee. All measurement were carried out in the range of 400-4000 cm^{-1} at a resolution of 4 cm^{-1}. The dye samples were measured by using Perkin Elmer GX system, FT IR spectrophotometer.

UV-visible spectroscopy

The dye extracts were analyzed in UV- visible spectrophotometer at the range of 400- 800 nm with a resolution of 1 nm, to determine the wavelength of maximum absorption (λ_{max}) of the dye pigments. The maximum absorption wavelengths (λ_{max}) of extracted (water, ethanol and methanol) were 510 nm, 494 nm and 499 nm, respectively.

Determination of the Antimicrobial Activities of the Extracted Dyes

The extracted dye solutions were tested with *Aspergillus flavus, Bacillus subtilis, Candida albicans, Pseudomonas fluorescen, Xanthomonas oryzae* and *Echerichia coli* species to investigate the nature of antimicrobial activities by agar disc difffusion Method.

Dyeing the Extracted Natural Dye with Cotton Cloth

The pretreated cotton cloth was dye using dyes extracted (water, ethanol and methanol) from Ka-bwee. The concentration of (1000 ppm) dye solution dyeing on cotton cloth were studied in terms of temperature, contact time, pH and alum dosage. The temperature was varied in 40-90 °C, contact time varied in the range of 10-80 min and pH was changed in the value of 3-9 and alum dosage used in 0.025-0.15 g by using UV-visible spectrophotometer. And then, the most suitable conditions for dyeing on cotton cloth was selected. The amount of adsorption at equilibrium q_t (mg/g) and % removal of Ka-bwee dyes were calculated by this equation:

$$q_t(\text{mg/g}) = \frac{\text{Co} - \text{Ce (mg/L)}}{\text{unit mass of } adsorbent\ (g)} \times \text{volume of solution (L)}$$

Where, q_t = adsorption capacity (mg/g), C_o= initial concentration (mg/L)

C_e = equilibrium concentration (mg/L), unit mass of adsorbent = 1 g

Effect of temperature

Bath adsorption experiments were conducted by 1 g of cotton cloth to 100 mL of dye solutions with water in a 250 mL beaker with a temperature control of 80 °C ± 5 °C. A 100 mL dye solution in a 250 mL beaker was put in water bath. Natural dye solution dyeing on cotton was allowed to reach the equilibrium for 60 min in a water bath at 40, 50, 60, 70, 80 and 90 °C. At 10 min intervals, the dye solution was taken from the beaker. The remaining dye concentration was determined by UV-visible spectrophotometer at λ_{max} 510 nm for watery extracted dye. Similarly, sorption properties of ethanol and methanol were also determined at 40, 50, 60, 70, 80 and 90 °C at 494 and 499 nm, respectively.

Effect of contact time

The effect of contact time on dyeing the cotton cloth with the extracted dye on cotton cloth was conducted by the same procedure for an equilibrium over a range of contact times (10 – 80 min) in 250 mL beaker with a temperature control of 80 °C. At 10 min intervals, the dye solution was taken from the beaker. The remaining concentration was determined spectrophotometerically at its corresponding λ_{max} (510, 494 and 499 nm).

Effect of pH

The effect of pH on dyeing the cotton cloth with the extracted dye was conducted by the same procedure for an equilibrium over a range of pH values (3,4,5,6,7,8 and 9) which were adjusted with HCl and NaOH. The extracted dyes of water, ethanol and methanol dyes were applied to dye the cotton cloth and allowed to equilibrate for 60 min in a water bath at 80 °C. At 10 min intervals, the dye solution was taken from the beaker. The remaining concentration was determined spectrophotometerically at its corresponding λ_{max} (510, 494 and 499 nm).

Effect of alum dosage

The effect of alum dosage on dyeing the cotton cloth with the extracted dye was conducted by the same procedure for an equilibrium over a range of alum dosage (0.025 – 0.15 g). At 10 min intervals, the dye solution was taken from the beaker. The remaining concentration was determined spectrophotometerically at its corresponding λ_{max} (510, 494 and 499 nm).

Results and Discussion

The physicochemical characteristics of Ka-bwee bark powder were determined. The results in Table 1 indicate 8.25 % w/w moisture content, 3.53 % w/w ash content, 0.80 g mL^{-1} bulk density, pH 6.70 in raw sample. The phytochemical results of the extracted dye from Ka-bwee are shown in Table 2. Alkaloids, flavonoids, glycosides, phenolic compounds, saponin, steroids and tannins were observed in Ka-bwee dye whereas carbohydrates and starch were not found in this extracted dye sample.

Table 1 Physicochemical Properties of Ka-bwee Dyes

No.	Characteristic	Content
1	Moisture Content (%)	8.25
2	Ash Content (%)	3.53
3	Bulk Density (g cm^{-3})	0.80
4	pH	6.70

Table 2 Phytochemical Results of Ka-bwee Dye

No.	Test	Extract	Test Reagents	Observations	Remark
1	Alkaloids	1 % HCl	Mayer’s reagent	White ppt	+
2	α-Amino acid	H_2O	α-Ninhydrin reagent	Purple spot	+
3	Carbohydrates	H_2O	10 % Naphthol	Red ring	-
4	Flavonoids	EtOH	Mg turnings and conc;HCl	Pink	+
5	Glycosides	H_2O	10 % Leadacetate	White ppt	+
6	Phenolic compounds	EtOH	1 % $FeCl_3$	Deep blue	+
7	Saponins	H_2O	Distilled water	Frothing	+
8	Starch	H_2O	1 % Iodine solution	Deep blue	-
9	Steroids	PE	Acetic anhydride and conc:H_2SO_4	Blue or Blue green	+
10	Tannins	H_2O	1 % Gelatin	White ppt	+

EDXRF analysis

In this research, the natural dye was extracted from Ka-bwee by using water. The water extracted dye was characterized by EDXRF. From EDXRF analysis, the major constituent is calcium 46.38 % and potassium 23.26 % and silica 11.76 % were also observed.

Table 3 Relative Abundance of the Elements in the Watery Extracted Dye from Ka-bwee

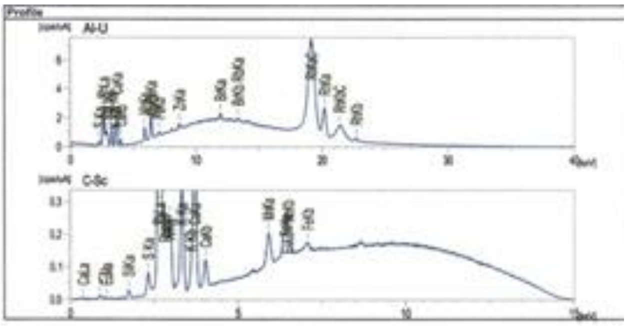
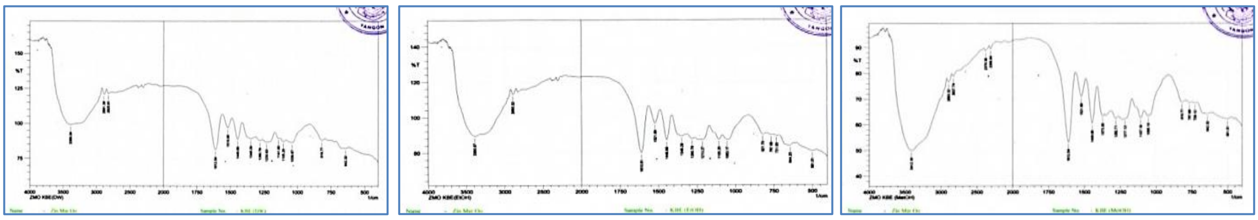


Figure 1 EDXRF spectra of the watery extracted dye from Ka-bwee

Element	Relative Abundance (%)
Ca	46.382
K	23.263
Si	11.763
S	6.846
Fe	5.425
Mn	4.603
Br	0.737
Zn	0.719

FT IR Analysis

Figure 2 shows the FT IR spectra of dyes extracted from Ka-bwee with water, ethanol and methanol. The characteristic absorption bands at 3300, 2891, 1446, 1105 and 642 cm^{-1} were observed. These peaks correspond to groups present in the sample and indicated to O-H stretching, C-H stretching, C-H bending, C-O stretching and benzene ring (quinone) which is the good correlation with that of literature. These bands confirmed the presence of alkaloids, tannins and flavonoids in natural dye (Table 4).



(a) (b) (c)

Figure 2 FT IR spectra of natural extracted dyes from Ka-bwee with (a) water, (b) ethanol and (c) methanol

Table 4 FT IR Assignments of the Extracted Dyes from Ka-bwee with Water, Ethanol and Methanol

Observed wavenumber (cm^{-1})			*Literature value(cm^{-1})	Possible Assignment
KBE-W	KBE-Et	KBE-Met		
3389.04	3390.97	3412.19	3950 - 3200	O-H stretching
2891.39	2893.32	2893.32	2980 - 2850	C-H stretching(CH_3) C-H stretching (CH_2)
1612.54	1610.61	1612.54	1700-1600	C=O stretching
1446.66	1446.66	1446.66	1465-1440	C-H bending
1105.25	1105.25	1055.10	1280-1030	C-O stretching
819.77	821.70	819.77	900-800	=CH bending
642.32	644.25	642.32	800-500	Benzene ring (quinone)

KBE-W =ka-bwee dye extracted with water

KBE-Et =ka-bwee dye extracted with ethanol

KBE-Met =ka-bwee dye extracted with methanol

* Silverstein *et al.*, 2003

UV- visible Analysis

Ultra violet spectra of natural dyes extracted from Ka-bwee dye are described in Figure 3. The wavelengthsof maximum absorption (λ_{max}) of extracted dyes were found to be 510 nm for water, 494 nm for ethanol and 499 nm for methanol extract.

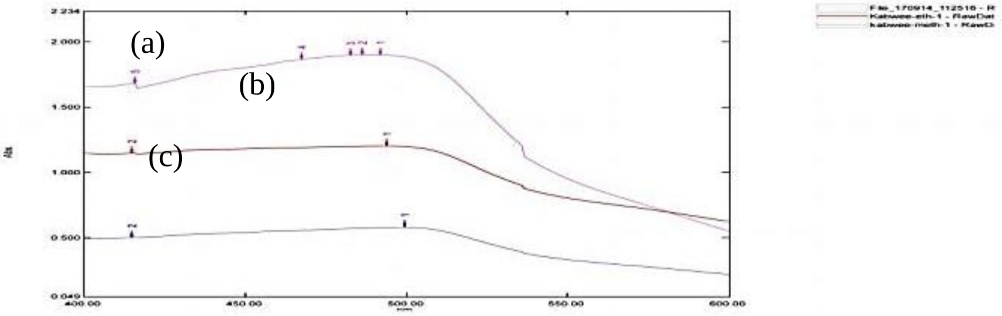
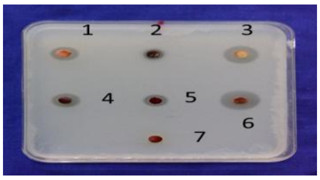


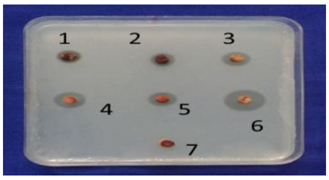
Figure 3 UV-visible spectra of Ka-bwee dyes extracted by (a) water, (b) ethanol and (c) methanol

Antimicrobial Activities of the Various Extracted Dyes from Ka-bwee

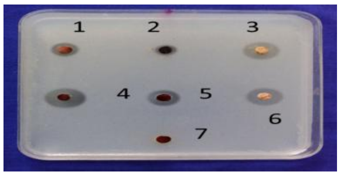
It was important to study the antimicrobial activity on dyes extracted from Ka-bwee because natural dyes showed inhibition effect against test bacterial in solution. The results are shown in Table 5 and Figure 4. Among these extracted dyes, watery extract did not show antimicrobial activity against test organisms. Petroleum ether extracted dye showed the highest activity while acetone, ethylacetate and methanol extract exhibited the lowest activity against six types of microorganisms. The antimicrobial activity might be due to ellagic acid and tannin components.



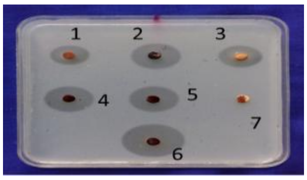
Aspergillus flavus



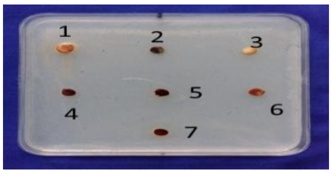
Bacillus subtilis



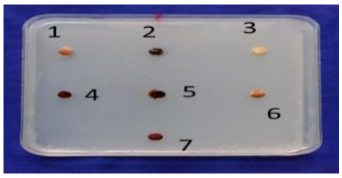
Candida albicans



Escherichia coli



Pseudomonas fluorescens



Xanthomonas oryzae

Figure 4 Antimicrobial activities of various solvent extracts of Ka-bwee dye(1.acetone, 2.chloroform, 3.ethylacetate, 4.ethnaol, 5.methanol, 6.pet.ether and 7. Water)

Table 5 Antimicrobial Activities of the Various Extracted Dyes from Ka-bwee

No.	Test Organisms	Acetone	$CHCl_3$	EtOAc	EtOH	MeOH	PE	H_2O
		Inhibition Zone Diameters (mm)						
1	*Aspergillus flavus*	+(12)	+(8)	+(14)	+(12)	+(10)	++(16)	-
2	*Bacillus subtilis*	+(12)	+(8)	+(14)	+(10)	+(12)	++(16)	-
3	*Candida albicans*	+(8)	+(10)	+(12)	++(14)	+(10)	+(12)	-
4	*Escherichia coli*	+(14)	++(18)	++(16)	++(18)	++(18)	+++(22)	-
5	*Pseudomonas fluorescens*	-	-	-	-	-	-	-
6	*Xanthomonas oryzae*	-	-	-	-	-	-	-

Agar Disc Diffusion Method -6 mm, 6 mm ~ 12mm (+), 15 mm ~ 19mm (++), 20 mm above (+++), No activity (-)

Sorption of the Extracted Natural Dye from Ka-bwee on Cotton Cloth

Effect of temperature

The adsorption properties of water, ethanol and methanol extracted dyes were studied at different temperatures (40-90 °C). In dyeing, the optimum temperature of extracted natural dyes on cotton was 80 °C.

Table 6 Adsorption Capacities of the Extracted Dyes at Different Temperature

Temperature (°C)	q_t(mg/g) KBE-W	KBE-Et	KBE-Met
40	59.19	56.17	43.87
50	70.29	60.62	48.71
60	64.57	59.83	46.48
70	67.59	65.92	57.59
80	80.72	69.54	62.31
90	80.59	69.24	62.08

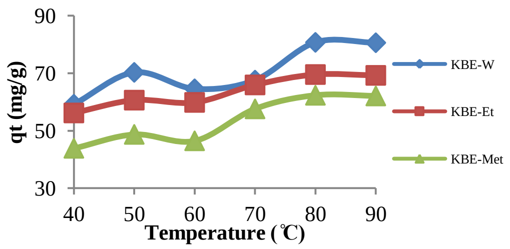


Figure 5 Effect of temperature on dyeing of Ka-bwee dye extracted by water, ethanol and methanol

Effect of contact time

Table 7 and Figure 6 show the amounts of extracted dyes applied on cotton cloth at different contact times (20, 30, 40, 50, 60, 70, 80 and 90 min) at 80 °C. It was found that the maximum sorption capacities were reached at 60 min.

Table 7 Adsorption Capacities of the Extracted Dyes at Different Contact Times

Time (min)	q_t(mg/g)		
	KBE-W	KBE-Et	KBE-Met
10	62.78	49.04	35.69
20	65.58	50.66	41.72
30	70.27	58.14	49.32
40	71.79	58.99	49.48
50	77.19	62.35	50.31
60	89.39	68.87	59.58

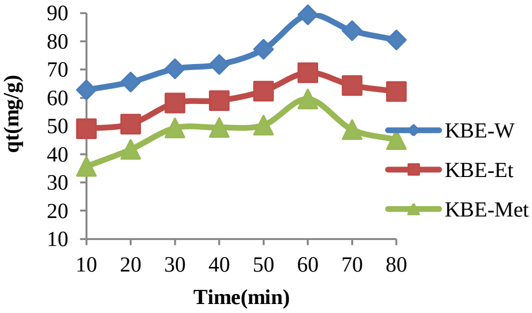


Figure 6 Effect of contact time on dyeing of Ka-bwee dye extracted by water ethanol and methanol

Effect of pH

The original pH of extracted dyes (water, ethanol and methanol) were 6.7, 6 and 7 respectively. The pH values of extracted natural dyes were adjusted with 1 % HCl and 1 % NaOH to reach the pH values of 3, 4, 5, 6, 7, 8 and 9. The optimum pH of extracted natural dyes was 6 (Table 8 and Figure 7).

Table 8 Adsorption Capacities of the Extracted at Different pH Values

pH	q_t(mg/g)		
	KBE-W	KBE-Et	KBE-Met
3	65.79	61.26	56.53
4	69.89	62.35	60.69
5	71.58	62.75	62.10
6	93.82	84.86	83.33
7	61.64	52.45	64.58
8	52.98	44.25	52.36

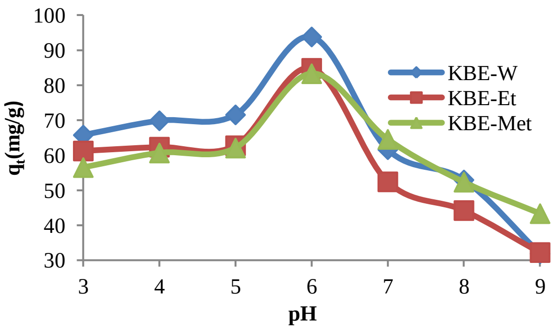


Figure 7 Effect of pH on dyeing Ka-bwee dye extracted by water, ethanol and methanol

Effect of mordant (alum) dosage

Table 9 and Figure 8 show the effective alum dosage of dyeing on cotton cloth. At the dye concentration 1000 ppm, contact time 60 min and temperature 80°C, the sorption properties of natural dye were studied at different alum dosages (0.0.25 to 0.15 g) by using UV-visible spectrophotometer. Among the different alum dosages, 0.1 g of alum dosage was the effective sorption capacity for dyeing process.

Table 9 Adsorption Capacities of the Extracted at Different Mordant (Alum) Dosage

Dosage (g)	q_t(mg/g)		
	KBE-W	KBE-Et	KBE-Met
0.025	73.12	61.58	56.12
0.050	76.40	65.63	57.14
0.075	72.77	61.45	62.74
0.100	80.72	75.52	73.78
0.125	74.34	67.66	69.34
0.150	65.04	60.45	62.31

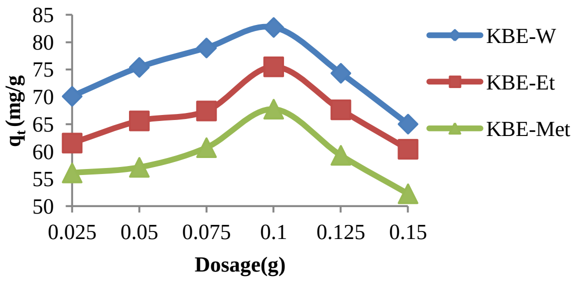


Figure 8 Effect of alum dosage on dyeing of Ka-bwee dye extracted by water, ethanol and methanol

Colour Fastness Properties of Ka-bwee Dye Extracted Dyes with Water Dyeing on Cotton Cloth

Colour density on the cotton cloth was increased significantly when a mordant was used. The colour fastness cotton cloth samples were prepared using pre-mordanting, simultaneous mordanting and post mordanting, 0.2 % v/v dye concentration and 60 min dyeing time because those conditions resulted in the highest colour strength for cotton cloth. The colour density for Ka-bwee dye extracted with water solution dyeing cotton cloth before and after colour fastness testing were compared in Tables 10,11,12 and 13 and Figures 9, 10, 11 and 12. For the dyeing on cotton cloth, the dyed cotton cloth without mordant was seen the lowest colour density. The dye (without) was seen the lowest colour intensity. Among mordants, natural mordant (jengkol peel) was used for the highest colour density whereas onion and teawaste were nearly equal colour density. It was also found that alum showed the good appearance and jengkol peel was good in colour fastness (Li *et al*., 2016).

Table 10 Colour Density of Cotton Cloth Dyed with Water Extract of Ka-bwee Dye

Type of mordanting	Colour Density/Mordants				
	Blank	Alum	Onion	Jengkol	Teawaste
Pre-mordanting	0.36	0.41	0.36	0.68	0.42
Simultaneous mordanting	0.35	0.40	0.38	0.75	0.45
Post mordanting	0.36	0.40	0.40	0.94	0.47

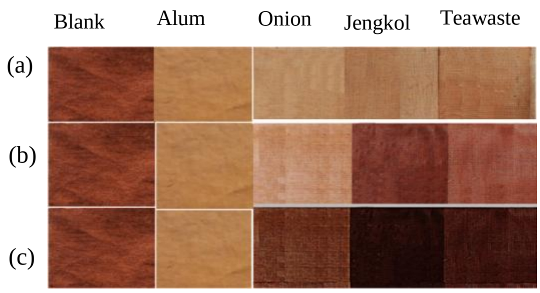


Figure 9 Colour of cotton cloth dyeing with water extract (a) pre-mordanting, (b) simultaneous mordanting and (c) post mordanting

Table 11 Variations in Colour Density of Cotton Cloth Dyed After Fastness Test (Pre-mordanting with Water Extract of Ka-bwee Dye)

	Colour Density / Mordants				
Mordant	**Blank**	**Alum**	**Onion**	**Jengkol**	**Teawaste**
Before	0.36	0.41	0.36	0.68	0.42
lighting	0.32	0.39	0.32	0.73	0.40
Washing	0.33	0.37	0.44	0.70	0.35

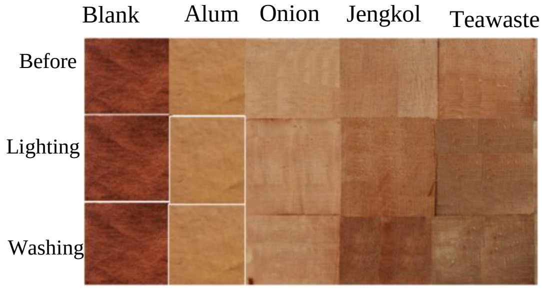


Figure 10 Colour of cotton cloth dyeing with water extract of pre-mordanting

Table 12 Variations in Colour Density of Cotton Cloth Dyed After Fastness Test (Simultaneous Mordanting with Water Extract of Ka-bwee Dye)

	Colour Density / Mordants				
Mordant	**Blank**	**Alum**	**Onion**	**Jengkol**	**Teawaste**
Before	0.35	0.40	0.38	0.75	0.45
lighting	0.34	0.38	0.33	0.76	0.42
Washing	0.32	0.37	0.45	0.73	0.37

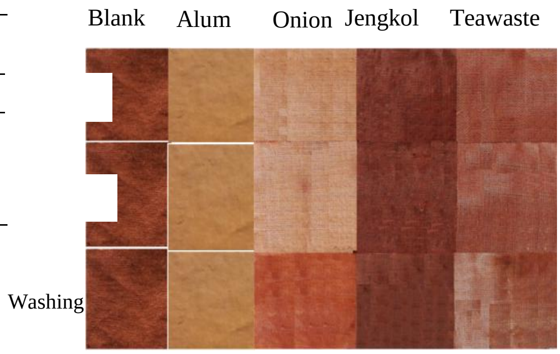


Figure 11 Colour of cotton cloth dyeing with water extract of simultaneous mordanting

Table 13 Variations in Colour Density of Cotton ClothDyed After Fastness Test (Post Mordanting with Water Extract of Ka-bwee Dye)

	Colour Density / Mordants				
Mordant	**Blank**	**Alum**	**Onion**	**Jengkol**	**Teawaste**
Before	0.35	0.38	0.40	0.94	0.47
Lighting	0.32	0.36	0.35	0.95	0.44
Washing	0.32	0.36	0.38	0.93	0.39

Figure 12 Colour of cotton cloth dyeing with water extract of post mordanting

Table 14 Difference before and after Wash Fastness (Post Mordanting) Properties of Five Dye Solutions on Cotton Cloth

Desorption values	**Blank**	**Alum**	**Onion**	**Jengkol**	**Teawaste**
	5.71	5.26	5	1.06	17.02

Conclusion

Natural dyes were extracted from Ka-bwee bark powder with different solvents (water, ethanol and methanol) by extraction method. The physicochemical properties of Ka-bwee raw bark were investigated. The physicochemical parameters of Ka-bwee raw bark, such as moisture content 8.25 %, ash content 3.53 %, bulk density 0.80 gcm^{-3}, pH 6.70 were observed. In phytochemical test, tannins, steroids, alkaloids, flavonoids, glycosides, phenolic compounds, saponins and α-amino acids were observed in the extracted dyes of water, ethanol and methanol. Whereas carbonhydrates and starch were not observed in this extracted dye. According to the FT IR analysis, Ka-bwee dyes extracted by different solvents, functional groups of OH, C-O, C=O(stretching),=CH bending and benzene ring were observed. From EDXRF analysis, the major constituent is calcium 46.38 % and potassium 23.26 % and silica 11.76 % were observed. Furthermore, antimicrobial activities of acetone, chloroform, ethyl acetate, ethanol, methanol, petroleum ether and water extracted dye from Ka-bwee were investigated by agar disc diffusion method. Among these extracted dyes, watery extract did not show antimicrobial activity in against test organisms. Among them, petroleum ether extracted dye showed the highest activity while acetone, ethylacetate and methanol extract exhibited the lowest activity against six types of microorganism. In this Ka-bwee dye, petroleum ether extracted dye inhibited antimicrobial activity in all tested organisms except *Pseudomonas fluorescens and Xanthomonas oryzae.* It was obvious that antimicrobial properties are closely related to the extracted solvent and dye structure, especially the presence of functional groups on it. Although dyes are tannin based, their antimicrobial activity differs greatly. The maximum absorption wavelengths (λ_{max}) of Ka-bwee dyes extracted by water, ethanol and methanol were 510, 494 and 499 nm, respectively. The factors effecting the dyeing on cotton cloth such as temperature, contact time, pH and alum dosage were studied. For dyeing on cotton cloth, the optimum temperature at 80 °C, alum dosage 0.1 g, contact time 60 min and pH 6 were observed. Among the various extracted natural dye, watery extracted dyes are the most suitable for dyeing on cotton cloth. The colour fastness of dyed samples by pre-mordanting, simultaneous mordanting and post mordanting were determined. In this, the light fastness of post mordanting method is better than the other two methods. For the dyeing on cotton cloth, the dyed cotton cloth without mordant was seen the lowest colour density. Among these mordants, natural mordant (jengkol peel) was observed the highest colour density whereas alum, onion peel and teawaste were nearly equal colour density. According to the desorption properties, natural mordant (jengkol peel) was good colour fastness among the five mordants. The dye plants produced fine colour on textile, food and drink. The present study showed that natural dye extracted from bark of plant was non-toxic and cost effective for the eco-system.

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