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The Application of *Gluta Aptera* Wood (Rengas) as Natural Dye on Silk and Cotton Fabrics

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Abstract:

Natural dyes are considered as sustainable and eco-friendly dyes. They can produce different shades of colours and have lower colour fastness than synthetic dyes. The products of natural dyes are very much in demand due to their ability to produce different shades and eco-friendly nature. The normal method to produce natural dyes from plants is by boiling in water and the coloured extract produced is dyed on fabric The colurs of natural dyes from plants come from leaves, barks, roots , fruits or berries. In this study, waste from Gluta aptera wood (Rengas), obtained from Wood Engineering Laboratory at Forest Research Institute of Malaysia (FRIM), was tried and used as natural dye source due to the colour of the wood which is blood-red. The boiling and solvent extraction methods were used to obtain the dyes. The extracted dyes were applied on silk and cotton fabrics and their comparison in term of colours and shades on substrates, method of extractions as well as their ability to witstand washing, light and perspiration were compared.

Keywords: Colourfastness, Extraction, Gluta Aptera, Natural Dyes

1.0 Introduction:

Natural dyes are seen as eco-friendly dyestuff because they are derived from natural sources (Ali et al., 2009; Samanta et al., 2010; Montazer & Parvinzadeh 2007). The dyes also have better biodegradability in comparison with synthetic dyes (Kulkarni et al., 2011). Natural dyes can offer not only a rich and variation of source of dyestuff but also have a far superior aesthetic quality, which is more pleasing to the eye due to unique natural colour (Vankar, 2007). Natural dyes can be obtained from vegetations (extracted from root, leaf bark, trunk, fruit and flower of plants), animals (derived from cochineal and shellfish), and minerals (derived from soils, clay sources) (Manhita et al., 2011; Bechtold & Mussak, 2009; Senthilkannan, 2010). The most common colours of natural dyed products on fabric are yellow and brown.

Natural dyes are normally extracted using boiling method. However, colours from plants can be extracted using chemical which is an organic solvent. The colour compound in plants may vary in polarities depending on their chemical structure. Therefore, they need different solvents for extraction (Shrivastava & Dedhia, 2006). According to Wounter & Verhecken (1989), the most common method for natural dyes extraction are involved the use of hydrochloric acid (HCl) and methanol (MeOH). The application of waste materials as sources of natural dyes may cut down cost of natural dyeing as well as can preserve the enviroment. *Gluta aptera* (Rengas) is one of the famous hard-medium woods which can be found in Sumatra, Peninsular Malaysia and Borneo. It's a medium to large tree in size which the wood is blood-red in colour, streaky and moderately durable if exposed to the weather (Menon, 2004). In general, the woods are used to make structural components, roofing, staircase, flooring, walling as well as door and window frames.

Forest Research Institute of Malaysia (FRIM) generates significant amount of saw-wood waste and *Gluta aptera* is one of them. Previous research was done to identify pigment content of this wood bark and a phenolic compound of flavonoid was found (Copriady et al., 2002; Imamura et al., 1979). Flavonoids are a class of plant pigments that occur mainly in flowering plants and ferns and they are an important group of phenolic compounds (Armstrong, 1992). At present no specific information and research have been described on the use of natural dyes from this wood. Figure 1 shows a representative molecular structure of the flavones colouring components in extract compound. In this study, the waste from saw-wood of Gluta aptera obtained from Wood Engineering Laboratory at Forest Research Institute of Malaysia (FRIM) as shown in Figure 2 was tried and used to be as natural dyes source.

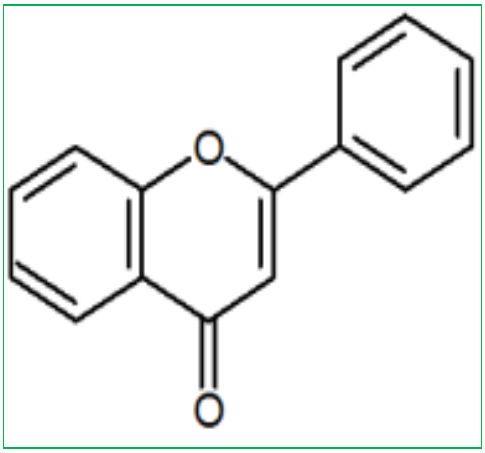

Fig 1: Molecular structure of the flavones (2-phenyl-1,4-benzopyrone)

Fig 2: Gluta aptera wood

Fig 3(b): Rice husk ash

Fig 3(a): Aluminum Potassium Sulfate

Fig 4: Extract solution of *Gluta aptera* (Boiling method)

Fig 5(a): Dried crude

2.0 Materials and Methods:

2.1 Materials:

2.1.1. Source: *Gluta aptera* saw-wood shown in Figure 2 was obtained from Forest Research Institute of Malaysia (FRIM), Kepong, Malaysia

2.1.2. Substrate: 100% satin weave silk and 100% plain weave cotton fabrics were used for the dyeing.

2.1.3. Chemicals: Methanol and acidified methanol (methanol + 0.1 % HCl) was used for solvent extraction. 4 % of Aluminum Potassium Sulfate ($AlK(SO_4)2.H_2O$) (Figure 3a) were used to compare with the resulting colour produced from natural mordant (rice husk ash) (Figure 3b).

2.2 Methods:

2.2.1 Extraction of Dyes:

Two types of extraction methods were used in the study. In the boiling method as shown in Figure 4, a liquor ratio of 1:20 (weight of materials in gram: amount of water in mL) was used to boil crushed wood in distilled water for 60 minutes. The mixture was then cooled down before being strained and the extract was used to dye fabrics.

In the solvent extraction method, a liquor ratio of 1:20 (weight of materials in gram: amount of methanol in mL) was used to soak crushed wood in methanol and 0.1% HCl was added for acidified methanol. The mixtures were soaked 48 hours at room temperature and placed inside dark room. The mixtures were then filtered to obtain the extracts. The extract was evaporated using rotary evaporator to produce crude (dyes in form of paste). The crudes from both methanol and acidified methanol were used to dye the fabrics. In order to convert into powder, the crude was dried inside desiccators for 24 hours. The dried crude (Figure 5a) was mix with beta-cyclodextrin with a ratio of 1:1 and ground manually using mortar and pestle to form powder (Figure 5b).

2.2.2 Dyeing of Fabrics:

Two percent (2%) of dye in crude and and 4% of powder based on weight of fabric were used to dye silk and cotton fabrics. The fabrics were also dyed using dyes extracted from boiling method. Some 4% of each mordant was used to fix the colour on to fabric. The fabrics were dyed with a dye solution using a liquor ratio of 1:20. Dyeing and mordanting was done simultaneously in one bath. The dyeing process was carried out at boiling temperature for 1 hour. After the process was completed, the dyed fabrics were rinsed with cold water and then left to dry.

Fig 5(b): Dye powder

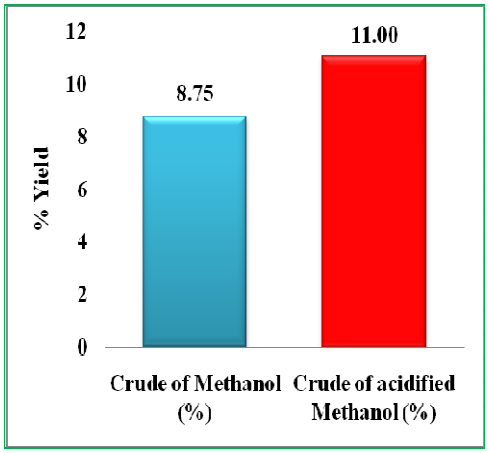

Fig 6: Average yield of crude produced

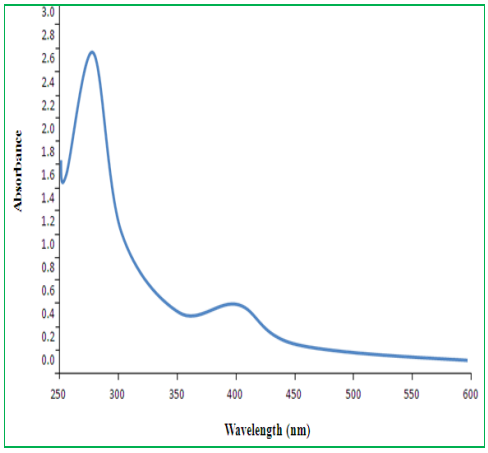

Fig 3: Absorption spectra of *Gluta aptera*

3.0 Results and Discussion:

3.1 Dyed Fabrics:

The samples of silk and cotton dyed fabrics using *Gluta aptera* are shown in Table 1. The *Gluta aptera* extracted from the boiling method gave comparable brownish shades in comparison with dyes extract from methanol and acidified methanol (crude and powder form). The dyed samples with crude (acidified methanol) gave brightest brown shade on both silk and cotton fabrics. However, dyeing using rice husk ash as mordant and without mordant (control) shows comparable shades on both silk and cotton dyed.

Table 1: Silk and cotton dyed samples

Form of dyes	Silk			Cotton		
	Mordants					
	Alum	Rice husk ash	Without mordant	Alum	Rice husk ash	Without mordant
Liquid (Boiling)						
Crude (methanol)						
Crude (acidified Methanol						
Powder (methanol)						
Powder (acidified methanol)						

3.2 Yield of Crude and Powder:

The yield of crude produced by chemical extraction were expressed in percentage and are shown in the Figure 6. The crude yielding from methanol extract was 8.75 percent in comparison with acidified methanol which produced 11 percent of crude. Therefore, the yield of powder was also higher in acidified methanol compared to methanol extract. Higher amount of yield produced by acidified methanol is due to the presence of acidic condition which provides lower pH of extract solution. According to Sharif, (2010) the used of hydrochloric acid in methanol provides a favourable medium for formation of stable ion and does not promote pigments degradation thus enhance the extraction yield.

3.3 UV-Vis Analysis:

The extract was subjected to Perkin Elmer Lambda 35 UV-Vis Spectrophotometer for absorption spectra analysis and the result is shown in Figure 3. It show a broad the absorption spectra for *Gluta aptera* extract ranging from 270 nm to 400 nm. This may indicate that *Gluta aptera* is multicoloured material. The peak of λmax wavelength is at 278 nm. According to Kamonchanok (2008) the brown extract from sappan wood (*Ceasalpinia sappan L.*) which is flovonoid pigment showed λ_{max} 276 nm (Kamonchanok et al., 2008). The value obtained for *Gluta aptera* is in agreement with previous finding.

*3.4 Measurement of L*a*b* Values:*

Table 2 shows L*a*b* values for silk and cotton dyed with *Gluta aptera* extract from boling and methanolic methods respectively. The L* value indicates perceived lightness or darkness where value of 0 indicate black and 100 indicate white. The values of a* and b* indicates red (+a) and green (-a) while b* value indicates yellow (+a) and blue (-b). Generally, the colours obtained through the application of alum, rice husk ash and without mordant (control) ranged from red and yellow. The darkest colour (brown) was obtained by dyed cotton without mordant (L*=75.15) and the lightest colour, light brown (L*=55.93) was achieved by dyeing with powder (methanol) and rice husk ash as mordant.

3.5 Colourfastness Properties:

Wash fastness results for dyed silk as shown in Table 3 indicate that the change in colour are moderate to good results as the rating is from 2/3 to 4 with good staining rating from 4 to 5. The same results were obtained from colourfastness perspiration which gave rating from 3 to 3/4 for change in colour and good staining results as well. In addition, colourfastness for rubbing gave excellent results with rating from 4 to 5 in both dry and wet rub as shown in the table. Poor to moderate results were obtained for light fastness test which gave ratings from 2 to 4. Cotton dyed results for wash fastness rating for change in colour is from 3 to 4 which indicate good fastness. In addition, the result for staining indicates good to excellent results which gave rating from 4 to 5. Colourfastness to perspiration results gave 3 to 4 rating for change in colour which indicate moderate to good results thus the good result is continued for staning on both cotton and wool. Rubbing fastness shows rating from 4 to 5 which indicate excellent fastness in both dry and wet rubs. However, poor results goes to light fastness properties as the results shown in the rating was from 2 to 3. These results were obtained ~~are~~ due to poor bonding of the dye molecules in the fibers as they exposed to light. The fastness properties results for cotton dyed using Gluta aptera gave a comparable results in comparison with silk dyed fabric.

Table 2: L*a*b* values for silk and cotton dyed with Gluta aptera

Extraction	Mordant	L*	a*	b*
Silk				
Liquid (Boiling)	Alum	68.49	12.36	21.91
	Rice husk ash	61.67	8.01	19.14
	Without mordant	69.42	7.96	21.26
Crude (Methanol)	Alum	61.66	18.57	31.46
	Rice husk ash	59.10	8.01	29.07
	Without mordant	67.97	8.41	30.51
Crude (Acidified methanol)	Alum	62.93	20.55	28.98
	Rice husk ash	59.39	9.61	25.87
	Without mordant	59.57	12.49	26.47
Powder (Methanol)	Alum	60.71	18.65	37.52
	Rice husk ash	55.93	10.68	22.04
	Without mordant	59.95	10.59	23.58
Powder (Acidified methanol)	Alum	62.93	20.55	28.98
	Rice husk ash	59.39	9.61	25.87
	Without mordant	59.97	12.49	26.42
Cotton				
Boiling	Alum	72.23	9.17	21.20
	Rice husk ash	70.74	3.65	13.50
	Without mordant	75.15	3.40	16.69
Crude (Methanol)	Alum	63.77	18.19	35.05
	Rice husk ash	65.63	9.90	10.24
	Without mordant	64.94	10.23	13.94
Crude (Acidified methanol)	Alum	68.46	13.96	25.31
	Rice husk ash	64.56	9.50	8.65
	Without mordant	62.81	10.21	13.03
Powder (Methanol)	Alum	63.77	18.19	35.05
	Rice husk ash	65.63	9.90	10.24
	Without mordant	64.94	10.23	13.04
Powder (Acidified methanol)	Alum	68.46	13.96	25.34
	Rice husk ash	64.56	9.50	8.65
	Without mordant	62.81	10.21	13.03

Table 3: Results of colourfastness for silk dyed using Gluta aptera

Dyes	Mordants	Washing			Perspiration			Rubbing		Light
		Colour change	Staining		Colour change	Staining		Dry	Wet	
			Silk	Cotton		Silk	Cotton			
Liquid	Alum	3	4/5	4/5	3	4/5	4/5	4/5	4/5	3
	Rice husk ash	3/4	5	4/5	3	4/5	4	4/5	4	2
	Without mordant	2/3	4	4	3	4/5	4	4/5	4	2
Crude (MeOH)	Alum	3	4/5	4/5	3	4/5	4/5	4/5	4/5	3
	Rice husk ash	3	4/5	4/5	3/4	4/5	4/5	4/5	4/5	3
	Without mordant	2/3	4	4	3/4	4/5	4	4/5	4	2
Crude (MeOH + HCl)	Alum	3	4/5	4/5	3/4	4/5	4/5	4/5	4/5	3
	Rice husk ash	3/4	5	4/5	3/4	4/5	4/5	4/5	4/5	3
	Without mordant	3	4/5	4/5	3/4	5	4/5	5	5	3
Powder (MeOH)	Alum	3/4	5	4/5	3/4	4/5	4/5	4/5	4/5	3
	Rice husk ash	3/4	5	4/5	3/4	5	4/5	4/5	4/5	4
	Without mordant	3/4	4/5	4/5	3	4/5	5	4/5	4/5	3
Powder (MeOH + HCl)	Alum	3	4/5	4/5	3	4/5	4/5	4/5	4/5	2
	Rice husk ash	4	5	5	3/4	5	4/5	4/5	4/5	3
	Without mordant	3/4	5	4/5	3	4/5	4/5	4/5	4/5	3

Table 4: Results of colourfastness for cotton dyed using Gluta aptera

Dyes	Mordants	Washing			Perspiration			Rubbing		Light
		Colour change	Staining		Colour change	Staining		Dry	Wet	
			Cotton	W ool		Cotton	W ool			
Liquid	Alum	4	5	4/5	4	5	5	4/5	4/5	3
	Rice husk ash	3/4	5	4/5	3	5	4/5	4/5	4/5	3
	Without mordant	3/4	5	4/5	3	4/5	4/5	4/5	4/5	3
Crude (MeOH)	Alum	3	4	4	3	4/5	4	4/5	4/5	3
	Rice husk ash	3/4	4/5	4	3	4/5	4	4/5	4/5	3
	Without mordant	3/4	4	4	3	4	4	4/5	4	2
Crude (MeOH + HCl)	Alum	3	4/5	4	3	4/5	4	4/5	4/5	3
	Rice husk ash	3/4	4/5	4/5	3	4/5	4/5	5	4/5	3
	Without mordant	3/4	4/5	4/5	3	4/5	4	5	4/5	2
Powder (MeOH)	Alum	3	4/5	4	3	4/5	4	4/5	4/5	3
	Rice husk ash	4	4/5	4/5	3/4	4/5	4/5	4/5	4/5	3
	Without mordant	3/4	4/5	4	3	4	4/5	4/5	4	2
Powder (MeOH + HCl)	Alum	3	4	4	3	4/5	4	4/5	4	3
	Rice husk ash	3/4	4/5	4/5	3	4/5	4	4/5	4/5	3
	Without mordant	3/4	4/5	4	3	4/5	4	4	4	2

4.0 Conclusions:

From the study, it can be said that the saw-wood from *Gluta aptera* which are usually removed or disposed from wood processing can be natural dyes source. Natural dyes from *Gluta aptera* showed interesting colours and shades on silk and cotton fabrics. The dyes from *Gluta aptera* gave variety of brown shades with acceptable colourfastness properties. The powder form is the ideal form of dyes since it is easy to handle and has longer shelf life. This form of natural dyes has potential to be introduced in textile dyeing industries as it has longer shelf life and also can be used in textile printing industries.

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References:

1) Ali, S., Hussain, T., & Nawaz, R. (2009). Optimization of alkaline extraction of natural dye from henna leaves and its dyeing on cotton by exhaust method. Journal of Cleaner Production, 17, 61-66.
2) Armstrong, W.P. (1992). Logwood and Brazilwood: Trees That Spawned 2 Nations. Pacific Horticulture, 53, 38-43.
3) Bechtold, T., Ali, A.M., & Mussak, R. (2006). Natural dyes for textile dyeing: A comparison of methods to assess the quality of Canadian golden rod plant material. Dyes & Pigments, 75, 287-293.
4) Copriady, J., Miharty, Herdini. (2002). Gallokatekin: Senyawa Flavonoid Lainnya Dari Kulit Batang Rengas (Gluta renghas Linn.)., Jurnal Natur Indonesia, 4 (1), 1-6.
5) Imamura, H., Ohta, H., Kiriyama, S., & Oshahi, H. (1979). Heart wood conctituent of rengas, Gluta sp. Bulletin of Agriculture, 117-122.
6) Kulkarni. S.S, Gokhale. A.V, Bodake.U.M and Pathade.G.R, 2011, Cotton dyeing with Natural Dye Extracted from Pomegranate Peel, Universal Journal of Environmental Research and Technology, Vol. 1(2): 135-139.
7) Manhita, A., Ferreira, T., & Candeias, A. (2011). Extracting natural dyes from wool-an evaluation of extraction methods. Analytical and Bioanalytical Chemistry, 400, 1501-1514.
8) Montazer, M. & Parvinzadeh, M. (2007). Dyeing of wool with Marigold and its properties. Fibers & Polymer, 8(2), 181-185
9) Samanta, A.K., Konar, A., & Chakraborti, S. (2010). Dyeing jutewith tesu extract: Part 1-Effects of different mordants and dyeing process variables. Indian Journal of Fibres & Textile Research, 36, 63-73.
10) Senthilkannan, M.S. (2010). Natural dyes: Are they really enviromentally friendly?. Consumer Testing Lab Services, SGS India (P) Limited.
11) Sharif, A. (2010). Extraction of natural colorants from onion (Allium cepa) skins using pressurized liquid extraction (PLE) for application in fabric dyeing (Master's thesis).
12) Shrivastava, A., & Dedhia, E.M. (2006). Extraction and dyeing methods for natural dyes. Natural dyes: Scope and challenge (pp. 67-80). The Maharaja Sayajirao University of Baroda, Vadodara, India
13) Vankar, P.S., Shanker, R., Dixit, S., Mahanta, D., & Tiwari, S.C. (2008). Sonicator dyeing of modified cotton, wool and silk with Mahonia napaulensis DC. And identification of the colorant in Mahonia. Journal of Industrial Crops and Products, 27, 371-379.
14) Wounter, J. & Verhecken, A. (1989). Study Conservation, 34, 189-200.