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DYEING OF SILK FABRIC WITH EXTRACT FROM CAESALPINIA SAPPAN

Basitah Taif
Faculty of Art & Design, Universiti Teknologi MARA, Shah Alam, 40450, Selangor, Malaysia
taifbasitah@hotmail.com

Rosita Mohd. Tajuddin
Faculty of Art & Design, Universiti Teknologi MARA, Shah Alam, 40450, Selangor, Malaysia
rosyta.mt@gmail.com

Siti Hernida Mohd Som
Faculty of Art & Design, Universiti Teknologi MARA, Shah Alam, 40450, Selangor, Malaysia
nydalicious@yahoo.com

Abstract

Dye extract derived from Caesalpinia sappan bark has been studied for incoherent colour saturation and poor fastness properties by local textile craftsman in Malaysia. This research was carried out to investigate the intensity of colour absorbed by silk fibre and its fastness properties against light. Boiling method was applied to extract its natural colourant; and mordanting and dyeing were conducted through pre-mordanting, simultaneous mordanting and post-mordanting procedures. Visual observations were made to examine the shades of dyed samples and the lightfastness properties were analysed via grey scale method. The dye ability results showed that all fabric samples appeared in different range of shades where the darkest colour of Post-mordanting was discovered almost similar to the control sample. It is concluded that natural dye extracted from the Caesalpinia sappan bark produced variation of shades on silk fabrics and the range of fading indicates resemblance between treated and untreated fabric.

Keywords

Natural Dye, Boiling, Caesalpinia Sappan, Mordanting

1. Introduction

Dyeing of textiles with natural dyes has been practising across the world by different societies since ancient times including the Malay textile craftsman. The colourant was extracted from various plant resources mainly from a wide range of barks, leaves, seeds, fruits, stems and roots (Perbadanan Kemajuan Kraftangan Malaysia, 1996). One of the most available natural dyes comes from the boiled sepang's wood or *kayu sepang* (Senarai Istilah Warna, 1981). Sappanwood is the species of Caesalpinia sappan from the legume family of Fabaceae (Cardon, 2007). The plant is also known as *pokok sepang* or *kayu sepang* in Malaysia. The wood was traditionally used to treat tuberculosis, diarrhoea, dysentery, skin infection and anemia among the locals (Badami, Moorkoth; & Suresh, 2002). Gu and Sun (2014), reported that it was commonly applied by the traditional Chinese medicine practitioners to promote blood circulation, relieve pain and swelling.

Various range of basic colours were obtained and some extended ones acquired through a combination of resources. In the process of Malay textile dyeing, the mixture of colours were applied onto silk yarn for the making of base woven textile which is songket. The extract is not only non-toxic to human but also environmental friendly. Syed Ahmad Jamal (2007) described that, the bark of sappanwood has been used to extract red dye for dyeing of silk yarn among the local Malay craftsman. The heartwood of Caesalpinia sappan contains a water-soluble property which allows colour to transform into red when oxidation process occurred. The red pigment is known as Brizilin. Oliveira, Edwards, Velozo and Nesbitt (2002) stated that, hue obtains from the extract is varied depending on its preparation. Yellow shade will appear if it is prepared in acidic solution and will turn to red in alkaline base. The result shows various shades depending on the concentration of dye and mordant. Brizilin source can be used to colour materials such as leather, wood, feathers and natural fibre such as silk, wool and cotton (Linh, 2009).

Ohama and Tumpat (2014) reported that, cotton fabric and silk yarn dyed with extract of sappan wood exhibited a range of colour from reddish brown, red wine to dark purple. This is due to the type of mordant, its concentration and mordanting techniques applied during extracting and dyeing procedures. Although, researchers such as Syed Ahmad Jamal (2007), Vankar (n.d); Omaha and Tumpat (2014) investigated different factors affecting dyeing ability, there are still many rooms for further research and improvement; mainly in the subject of woven

textile. Dyed yarns are constantly exposed to light as the weaving process requires bright and well-lit space to develop intricate patterns. This study was carried out to examine the established range of colours and the degree of fastness when silk fabrics dyed with the extracts were exposed against light. The results provide the best visual understanding of shades and degree of fastness when the fabric was exposed to light during the weaving process.

2. Material and Method

2.1 Material

In Peninsular Malaysia, Caesalpinia sappan or kayu sepang or pokok sepang in Figure 1; grows best on sandy river banks and along the road side. The species is thought to be a native of the regions located between central and southern India, then has spread into Burma, Thailand, Indochina and southern China, Peninsular Malaysia, Indonesia and the Philippines (Perkin & Everest, 1918).

Figure 1: *Caesalpinia sappan Tree*

The plant grows in small shrub with about 4 to 8 m in height and has a slim trunk that measures up to 15 cm in diameter. Zerrudo (1991) described the bark and heartwood as a source to extract red dye for textile dyeing. Craftsman discovered that both parts provide russet red hues or vermillion red if they are added with alumn (Thompson, 2007).

Lemmens and Wuljarni-Soetjapto (1992) categorized sappan as one of the common sources of plant material to be used in extracting natural dyes. Besides red dye, the bark and

wood also contain tannin that be able to naturally fix the colour onto fibre. However, the tree cannot be harvested until it has reached at least 8 to 10 years of growth as the wood would not be fully developed.

The selection of bark was made from a full-grown tree and unaffected with any kind of fungal or bacterial infection within the tree's vascular system.

2.2 Extract Preparation

The bark of Caesalpinia sappan or *kayu sepang* was obtained from the neighbourhood area and then cut into pieces for drying. The dried pieces were kept in a container to ensure that other residuals would not affected the later extract. Silk fabric samples were purchased from a local supplier.

Figure 2: *Bark of Caesalpinia sappan*

2.3 Mordant

Aluminium sulphate (Alumn 4%) was used as mordant. Mordanting and dyeing were conducted through pre-mordanting, simultaneous mordanting and post-mordanting procedures.

Table 1: *Formulation of Mordanting Silk (Samples)*

Preparation	**Condition**
Material-to- liquor	1:10
Aluminium sulphate (Alumn)	4% concentration
Temperature	Room temperature
Weight of the fabric's sample	0.25 gm (25 cm^2)

2.4 Dyeing Procedure

The dye extraction was performed by mixing the bark and silk samples in distilled water and boiled for 1 hour.

All silk fabric samples were treated via three different mordanting (pre-mordanting, simultaneous mordanting and post-mordanting) methods to dye and fix the Caesalpinia sappan extract onto the natural fiber, hence establishing the best range of hues for further evaluation. The control samples were dyed without alumn coating/fixing. Table 1 specify the conditions for its preparation.

2.5 Colour Assessment and Fastness Evaluation

Assessment of colours on the sample of fabrics was made through visual observation. The effect of different mordanting methods and dyeing and their association with controlled samples was investigated to provide beneficial knowledge between salt mordant (alumn), natural mordant (tannin) and colours.

In evaluating the fastness of samples to light, procedures were carried out according to the standard methods of ISO 105-B02:2014 or the Malaysian Standard for lightfastness test. The total exposure to light (Xenon Arc) was set at 120 hours with irradiance of 60 W/m^2 and relative humidity was 50% RH. The results of colour changed were analysed via grey scale where numerical ratings from 5 to 1 was applied (5=No change; 1=Maximum change).

3. Results and Discussions

The extraction of dye from Caesalpinia sappan's bark was carried and it has proven that the material contains colourant and natural tannin to bind the hue onto the silk's samples.

Colour of aqueous solution obtained from all experimental procedures are in brownish shades. Visual observation shows the appearance of colours on silk samples are within the range. Sample prepared without mordanting (control samples) as shown in Figure 3 displays similarities in term of hues with those mordanted; which highlights the small difference in the use of salt mordant and tannin.

Fabric sample that was dyed and mordanted through post-mordanting procedure (see Fig. 6) exhibited deep brown shade. The used of alumn and properties of natural tannin as mordant explain that double mordanting produced deeper colour than mordanting once.

Nevertheless, samples dyed and mordanted via simultaneous (see Fig. 5) procedure appeared in lesser hues compared to those with tannin (control). The change of colour is relatively slight in the case of only single mordanting involved.

In contrast, fabric sample which was experimented through pre-mordanting and dyeing as shown in Figure 4, appeared the lightest and the shade was dissimilar to samples experimented in other procedures. This vivid colour difference shows the decreased of shade when the two-separate dye-bath were required to bind the natural fibre.

These facts suggest that variables such as mordanting and dyeing procedures, salt mordant and tannin had influenced the development of shades that appear.

Figure 3: *Control Sample*

Figure 4: *Silk Sample Dyed through Pre-Mordanting and Dyeing Procedure*

Figure 5: *Silk Sample Dyed through Simultaneous Mordanting and Dyeing Procedure*

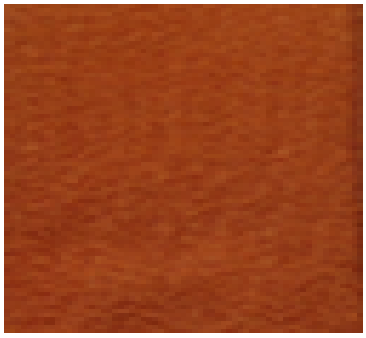

Figure 6: *Silk Sample Dyed through Post Mordanting and Dyeing Procedure*

The amount of colour alteration to light was measured through grey scale method and the results are shown in Table 2. Each of these recorded values was evaluated by comparing to five pairs of gray standards. The results show obvious contrast of colour (2) in all samples including the control samples.

Table 2: *Values of Light Fastness Test from Silk Fabric Samples Dyed with Sappan Extracts (ISO 105-B02: 2014)*

Silk Samples	**Procedures**	Lightfastness Rating	Colour Difference
Control	No Mordant	2	
D1	Pre-mordanting and Dyeing	2	
D2	Simultaneous mordanting and Dyeing	2	
D3	Post-mordanting and Dyeing	2	

The values were obtained after being exposed to light (Xenon Arc.) for 120 hours with irradiance sensor of 300-400 nm/60 W/m2 where all samples are in intermediate range of contrast. The procedures that were carried out according to ISO 105-B05:2014 standard had confirmed the colour change of all samples in the value of 2 via grey scale measurement.

4. Conclusion

Natural colourant extracted from the bark of Caesalpinia sappan established range of shades through various mordanting and dyeing procedures. These shades become a guideline to determine whichever of two mordants; alumn or tannin to be utilized in fixing the colourants onto silk fiber. The right choice of mordant is a great importance for the success of the overall extraction procedure as these two have similar affinity characteristics. Consistent shades are essential to maintain coherent values within the parameter of experiment. The result also suggested that the addition of salt alumn into the aqueous solution had not significantly altered the fixing properties and colours of the fabric samples.

It can be concluded that the difference of lightfastness rating between mordanted alumn samples and tannin samples (control) was minimal (rating 2). The number of values established from the grey scale show a connection of both when applied on silk fibre. It was found that the shades do not differ greatly against light when exposed for duration of 1 hour. Thus, analysis of changes could be conducted if longer period were to be applied in other experimental procedures.

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