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Eco-Friendly Primary Pigments from Indigenous Plants: Transforming Roselle, Turmeric, and Telang Flowers into Artist-Grade Colours

Pigmen Primer Mesra Alam daripada Tumbuhan Tempatan: Mengubah Bunga Roselle, Kunyit dan Telang menjadi Warna Gred Artis

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ABSTRACT Although natural dyes have been extensively researched for use in food and textile industries, their use in producing stable, mixable, and artist-grade primary colors for fine painting has not received as much attention. This study offers a new method for creating natural pigments made from telang flowers (Clitoria ternatea), turmeric (Curcuma longa), and roselle (Hibiscus sabdariffa), which naturally give red, yellow, and blue hues, respectively. Investigating the extraction method, analyzing color results, and evaluating these plant-based pigments' potential as sustainable substitutes for artistic applications are the goals of this study. Plant components were extracted using both water and methanol solvents and examined on drawing paper using a descriptive qualitative approach. In order to create stable, ready-to-use paints, the dried plant powders were mixed with Arabic gum, kaolin, rice flour, preservatives, and water in the second stage. The results showed that while the prepared pigment combinations produced saddle brown (roselle), yellow (turmeric), and green (telang), direct extracts produced magenta (roselle), yellow (turmeric), and sky blue (telang). The resultant colorants showed good surface adhesion and durability on paper, indicating that they might be used in creative mediums. The promise of native plants as sustainable, non-toxic, and renewable pigment supplies is highlighted by this study. The results open up new avenues for artists and scholars to investigate environmentally friendly alternatives in color creation and add to the expanding corpus of study on sustainable art materials.

INTRODUCTION

Plants are one of the main sources of natural dyes, and variotionus studies have been conducted to explore their potential. Erren and Humin (2019) explained that in Sabah, traditional colors are obtained from various parts of plants such as leaves, stems, roots and fruits which are used in handicrafts and textiles. Baskaran et al. (2019) reported that the telang flower (Clitoria ternatea) has long been used as a source of blue dye in woven fabrics in Pahang. Shahida et al. (2020) also stated that most natural dyes used in the weaving industry in Malaysia are plant-based. In addition, studies conducted by Imihezri et al. (2021), Mukmin et al. (2021), Michael et al. (2019), Aprimayumi et al. (2018), Dedi et al. (2017), Khammar et al. (2017), Norli et al. (2016) and Farida et al. (2013) found that several local plants in Malaysia have high potential as sources of natural dyes. The results of their study showed that these plant extracts produce stable pigments that are suitable for use in fabric dyeing. Therefore, since previous studies have proven that several plant species in Malaysia have natural dye properties that

https://doi.org/10.37134/kupasseni.vol14.sp.6.2026

are suitable for use in the textile industry, this study was conducted to investigate the potential of these local plants as environmentally friendly sources of pigments for the production of dyes for paintings and artworks.

Natural Dyes in Artwork

Natural dyes are not only used in the textile and food industries, but also have great potential in the field of visual arts such as painting and creative design. The use of dyes from plants as basic materials in painting has long been practiced in early civilizations such as Egypt, China, and India, where natural pigments were used to produce colors on walls, fabrics, and manuscripts. According to Rahimah and Zaiton (2018), natural dyes are able to produce soft, harmonious color tones and have their own aesthetic value compared to synthetic dyes. In addition, plant-based dyes are also safer to use because they do not contain harmful chemicals that can affect human health or pollute the environment (Latifah et al., 2020). Furthermore, natural dyes have high biodegradability and are renewable, making them more in line with the concept of sustainable art. Therefore, exploring the potential of local plants as a source of environmentally friendly dyes for artworks not only enriches artistic expression, but also contributes to the preservation of the environment and cultural heritage.

Studies on Local Plant Extracts in Malaysia

Studies on the use of local plant extracts as a source of natural dyes are receiving increasing attention among local and international researchers. This is due to awareness of the importance of environmentally friendly materials that can replace synthetic dyes that contain harmful chemicals. In Malaysia, various plant species have been identified as having high potential as natural dyes such as telang flower (Clitoria ternatea), turmeric (Curcuma longa), and roselle (Hibiscus sabdariffa). According to Norli et al. (2016) and Farida et al. (2013), all three plants produce bright and stable color pigments when extracted using natural solvents such as water or methanol. Studies by Imihezri et al. (2021) and Mukmin et al. (2021) also found that these plant extracts showed good color fastness when applied to cotton fabrics. Apart from the textile field, the potential of these local plant extracts should also be explored in the field of fine arts, especially in the production of color materials for painting. Research in this direction not only supports the development of art materials based on natural resources, but can also strengthen local heritage values and introduce a sustainable Malaysian art identity.

Overall, past studies have shown that local plants in Malaysia have great potential as a source of natural dyes that can be applied in various fields, especially the textile and handicraft industries. Researchers such as Erren and Humin (2019), Baskaran et al. (2019), and Shahida et al. (2020) have emphasized that most traditional dyes in Malaysia are obtained from plant parts such as leaves, roots, fruits and flowers. Further studies by Imihezri et al. (2021), Mukmin et al. (2021), and Norli et al. (2016) have proven that extracts from plants such as telang flowers, turmeric and roselle are able to produce stable and long-lasting colors when applied to fabrics. However, studies on the use of plant extracts as coloring agents in the field of fine arts are still limited. Therefore, this research was conducted to fill this knowledge gap by evaluating the ability of local plants to produce natural colors that are suitable for use in the production of artworks. This study is also hoped to contribute to the development of more sustainable, environmentally friendly coloring materials and in line with the principles of green art in Malaysia.

PROBLEM STATEMENT

The community is now increasingly aware of the importance of preserving greenery by initiating measures to reduce the effects of environmental destruction with the awareness to use materials and activities that can help reduce pollution to the environment, including in the production of art materials such as painting and painting. Therefore, as previous studies have recorded that some plants in Malaysia are proven to have dyes that can be used as natural dyes for textile enterprises, then this is an opportunity to examine whether dyes from these local plants can be used as materials. eco -friendly as a dye to produce paintings and paintings. In Malaysia, plants have been used as natural dyes in textile and food industries. Plants including mangosteen, turmeric, rambutan skins, and mango seeds are utilized as natural fabric colours but these natural dyes have not been widely used in visual art, such as in painting or drawing.

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OBJECTIVES

1. To develop a framework for extracting and formulating primary colourants derived from local plant sources.
2. To evaluate the stability and consistency of pigments produced from selected local plants.
3. To assess the potential application of plant-based colour mediums for use in artistic painting practices

METHODS AND MATERIALS

This study was conducted to explore the potential of local plants such as the telang flower (Clitoria ternatea), turmeric (Curcuma longa), and roselle (Hibiscus sabdariffa) as a source of natural dyes that can be used in the production of painting materials. Therefore, the methodology of this study focuses on the sample preparation process, color extraction techniques, and observation of the color results produced on the painting medium.

Mixed methods used in this research are to enhance the research possibilities in situations where we have multiple objectives to achieve, (R. Kumar, 2014). Therefore, this study will use descriptive qualitative and experimental methods. The data accumulations process will use observation (descriptive qualitative), to observe the creation of a natural colour mixture (descriptive qualitative), and testing the colour mixture sample on media (observation). D. P. Sedjati (2019) agreed with R. Kumar (2014) by mentioning a combination of the experimental method and practice-based research will go to make an actual using a sample of plant extract. Furthermore, systematic analysis data from the implementation of practice-based research have followed the theory of innovation the material has been done by experimentation earlier, (colour pigment extracted). A table will be used to describe the data acquired through observations in this study, which will list the names of the colours created on the paper.

Table 1. Method of plants Extraction

Name of plant	Type	Pigment colour	Method	References
Clitoria Ternatea/ Blue pigeon/ Bunga Telang	Flower	Blue	Traditional Extraction Distilled water (solvent) Methanol (solvent)	Norli et al, 2016 Mega Aprimayumi et al, 2018 I.K. Dedi et al, 2017 S.Michael et al. 2019
conCurcuma Longa / Kunyit	Rhizome	Yellow	Traditional Extraction Distilled water (solvent) Methanol (solvent)	Norli et al, 2016 T.Khammar et al 2017 I.K. Dedi et al, 2017
Hibiscus Sabdariffa / Roselle	Fruits / buck of fruit	Red	Traditional extraction Distilled water (solvent) Methanol (solvent)	Noli et al, 2016 Farida Ali, 2013
Peacock flower, bougainvillea, beetroot. Red cabbage and onion skin	Flower Skin Rhizome	Red Yellow Purple Orange	Traditional extraction Distilled water (solvent) Methanol (solvent)	Geetha B et al, 2013

Table 1, shows a variety of methods for eliciting plant pigment colour. It demonstrates that typical plant material extraction utilising solvents such as distilled water and methanol are the most effective approach for extracting plant pigment colour. To make use of plant pigment colour, the natural colourant must first be removed from the plant material. Three types of plants were selected for this study: blue

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Clitoria ternatea, yellow *Curcuma longa*, and red *Hibiscus Sabdariffa* (Roselle). Only materials, either fresh or dried and techniques that are safe to be conducted at home are chosen.

The initial step in any extraction operation is to prepare the material and plant material, which includes purchasing any necessary materials or instruments. Plant extraction is the next stage, followed by mixing the pigment yield with the binder and testing on paper media. Then, observation will be made to the mixer on paper medium and the cumulative data will be recorded. This is a flow sheet diagram representing the research framework (Figure 1)

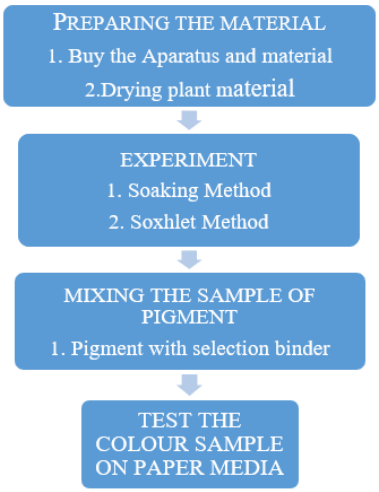

Figure 1. Framework of Elicitation Colorant from The Local Plants

SPECIES OF PLANTS	PICTURE OF PLANTS
Hisbiscus Sabdariffa L. (Rosselle)(Fruits)	
Blue Pigeon/Clitoria Ternate (Bunga Telang) (Petals)	

https://doi.org/10.37134/kupasseni.vol14.sp.6.2026

Curcuma Longa (Kunyit) (Rhizome)	

Figure 2. Types of Plants for Extraction

The study procedure was divided into two main phases, namely Phase 1: Plant Colour Extraction Process and Phase 2: Production of Painting Dyes from Plant Powders. In Phase 1, each plant — telang flower, turmeric and roselle — was dried at room temperature for several days before being finely ground using a food grinder to obtain a dry powder. The powder was then subjected to an extraction process using two types of solvents, namely water and methanol. The obtained colour extracts were then tested on drawing paper to identify the tone and stability of the resulting colour.

In Phase 2, dried plant powders are combined with additives such as gum arabic, kaolin, rice flour, preservatives and water to produce a natural dye mixture in liquid form. This mixture is stirred using a glass rod until well-blended and left for 24 hours before being tested on drawing paper to assess texture, durability and colour saturation.

Preparing The Material

The first step before starting the experiment, the author has made a preparation that is to prepare the tools and main materials that is the laboratory apparatus for the experiment and the main plant material that is roselle, turmeric and telang flowers. Next the initial preparation is also to dry the plant material to be stored until the experiment is carried out.

a. Plant Material
   The major plant ingredients, telang flower (clitoria ternatea/butterfly pea/blue pigeon) and turmeric were collected from Parit, a town in Perak Darul Ridzuan state's Central Perak area. Meanwhile, in the Venice Mosque in Manjung District, Perak Darul Ridzuan, roselle (Hibiscus Sabdariffa L.) was harvested from a food planting project. As a result, the first step is to dry the plants, which are then stored until the extraction experiment is carried out. Fresh plants are prepared a day before the date of experiment by storing them in the refrigerator to maintain their freshness.

b. Mixed Materials Needed to Produce Colours
   The second preparation is to obtain the mixed ingredients needed throughout the experiment namely binder (Arabic gum), preservatives, kaolin minerals, rice flour, glycerine preservatives, and distilled water solvents. Arabic gum powder, rice flour, distilled water, and plant-based glycerine preservatives were purchased from a cake and pastry ingredients supplier shop in Seri Iskandar, Perak. While kaolin is purchased from a supplier of cosmetics from Shopee.

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Extraction Process

a. Soaking Method

Each species of plants was weighed at the same weight and amount. A food grinder was used to grind the components into powder. The powder then was soak separately in distilled water and methanol (solvent) in the beaker. After 3 hours, the mixtures were strained.

b. Soxhlet method

The dried *Clitoria Ternatea* (*bunga telang*) flower was weighed. 250ml methanol was added into a round bottom flask. The round bottom flask was attached to a Soxhlet extractor and condenser on a dismantle. The dried material was loaded into a porous cellulose thimble. The thimble was then placed inside the Soxhlet extractor. The solvent was heated using the dismantle and would begin to evaporate, moving through the apparatus to the condenser. The condensate then drips into the reservoir containing the thimble. Once the level of solvent has reached the siphon it poured back into the flask and the cycle began again. The process should be two or three times. The condensate was put into the oven at 55 degrees Celcius to remove the solvent. The crude drug (yield) obtain was weighed. The process was repeated by replacing the dried flowers with fresh flowers.

Formulating The Watercolour Based colour

Before being blended with distilled water solvent, kaolin mineral or rice flour, binder material such as Arabic gum, and glycerin preservative, the dried plant materials were processed into dye powder.

Clitoria Ternatea (*Telang* flower) colouring powder has a range between dark blue to purple colour, whereas Roselle powder has a dark pink or magenta physical colour, and *Curcuma Longa* (turmeric) colouring powder has a yellow physical colour. These colour powders were kept in a closed glass bottle at room temperature, between 27 and 30 degrees Celsius.

For the first sample, a mixture of coloured powder with binder elements such as Arabic gum, kaolin mineral material, glycerin preservative, and solvent material such as distilled water with a ratio of 1: 1: 1: 1 was found to be well mixed and was thoroughly blended with a glass rod. The second sample was a mixture of colour pigments with the same ingredients as the first sample, but the kaolin mineral was replaced with rice flour, and the mixture was well mixed and stirred with a glass rod. Both samples of the mixtures were kept for 24 hours in glass bottles before being tested on drawing paper media. Colour compounds using these elements were left for 24 hours to verify that all ingredients were well blended and the characteristics were ready to be evaluated to see if there is a change in the colour produced. The physical colour of the blended samples were remained unchanged for 24 hours.

Observation

The method of observation of the sample performed was the last method in this investigation. Colour mixtures containing the above components were put to drawing paper and stored at room temperature. The purpose of this test is to see the resistant of the colour samples against time. The colour created on paper once they were completely dried was observed, as well as the colour fading level test over a four-week period. This experiment has tried to determine whether colours mixed with binders, preservatives, kaolin minerals, or rice flour have the ability to withstand time in a room temperature environment.

Tested on paper

After being left to dry, the prickly pear-coloured obtained from Roselle sample turned brown. During wet mixing the prickly pear hue (red) could not be retained. When rice flour samples were dried on drawing paper, the hue has changed to brown. When the blue colour sample obtained from *Clitoria Ternatea* flower *(telang* flower) was dried on paper, the colour obtained was green. The blue colour of *Clitoria*

https://doi.org/10.37134/kupasseni.vol14.sp.6.2026

Tenartea flowers has changed to green in both samples using the minerals kaolin and rice flour. According to Kuntapas K., et al (2014), *Clitoria Ternatea* colour pigment was mostly comprised of anthocyanins, which contains high antioxidant activity and the ability to change the colour according to the PH level of the surrounding, this condition indicated that when the colours were mixed with these ingredients, the PH level has changed and became more alkaline. The PH level of this sample was affected not only by the ingredients blended with the colour pigments but also by the surrounding factors, such as the paper used and the room used. Yusraini, D.I.S., et al. (2011) also determined that the red colour of Hisbiscus Sabdarifa (Roselle) was related to its acidic nature, which was at its best between PH levels of 2 and 3. This acid condition, he claimed, was also easily lost because it is soluble in water. As a result, the acidic qualities of the Roselle colour pigments were hydrated along with the water when the colour was dried. The fact that the colour pigment of *Clitoria Ternatea* and Roselle have changed from blue to green and red to brown indicated that the influence of PH level is significant in maintaining the pigment of the colours of *Clitoria Ternatea* and Roselle.

Curcuma Longa (turmeric) on the other hand, when was left to dry on paper, has produced a permanent yellow tint. As previously stated, the yellow colour was the major component of *Curcuma Longa* (turmeric) rhizomes, making it a more stable colour. In comparison to *Clitoria Ternatea* and Roselle, the antioxidant state of *Curcuma longa* tubers was assisted to the limit of the influence of PH on its colour from altering. Furthermore, as mentioned by K.Sachan & VP Kapoor, (2005) in their paper, *Optimization Of Extraction And Dyeing Conditions For Traditional Turmeric Dye, Curcuma Longa* (turmeric) has a persistent hue as a natural dye due to its water soluble qualities.

Although *Clitoria Ternatea* flower colour samples and Roselle samples showed some changes in the colours consistency when mixed with binder (Arabic gum), preservative (glycerin), kaolin mineral, rice flour, and water solvent, the colour resistance on paper against fixed time observations continued because brown and green were the colors found in the colour chart. The yellow hue created was stable, similar to *Curcuma Longa* yellow, and has the potential to be turned into a more organic water-based colour that does not contain toxic chemicals.

As a result, these three colours mixture samples from *Clitoria Ternatea,* Roselle, and *Curcuma Longa* (turmeric) were examined for sample resilience on paper that had been left at room temperature for four weeks.

RESULTS AND DISCUSSION

Phase 1 Findings: Plant Color Extract Results

The first phase of the study focused on producing colors from plant extracts using two types of solvents, namely water and methanol. The results of the observations found that each plant produced different color tones depending on the type of solvent used.
1. Telang Flower – Extract using water produced a light blue color (sky blue), while methanol solvent produced a deep blue color.
2. Turmeric – Extract using water and methanol each produced a bright yellow color that was stable and easily adhered to the surface of the paper.
3. Roselle – Water extract showed a purplish pink color (magenta), while methanol extract produced a darker brownish red color.

Observations over 24 hours showed that the color from methanol solvent was more stable than water, as it did not fade easily when exposed to air. This result is consistent with studies by Mukmin et al. (2021) and Dedi et al. (2017) who found methanol to be a more effective solvent in the extraction of plant pigments.

Findings of Phase 2: Painting Dyes from Plant Powders
In the second phase, dyes in powder form were produced by mixing dried plant powders with additives such as gum arabic, kaolin, rice flour, preservatives and water. The results of the observations showed changes in color tone when the pigment was combined with a binder:
• Roselle produced a medium brown color (saddle brown).
• Turmeric maintained a bright yellow color.

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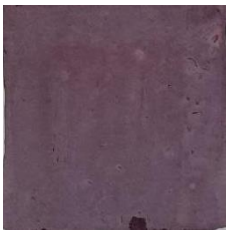
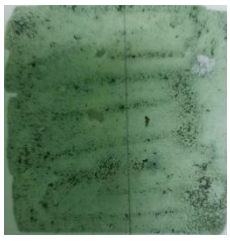
• Telang produced a soft green color when mixed with a binder.

The colors produced had a good texture, did not crack easily when dry, and showed strong adhesion to the paper surface. This observation proved that natural binders such as gum arabic and kaolin helped increase the stability and elasticity of the color.

The results of this study prove that local plants such as roselle, turmeric and telang flowers have high potential as a source of natural dyes for art materials. The resulting colors are not only stable and vary according to the solvent, but also show attractive aesthetic characteristics. This finding is in line with the findings of Erren and Humin (2019) and Shahida et al. (2020) who emphasized that Malaysian plants are unique in producing strong and long-lasting pigments. In addition, the use of natural materials such as gum Arabic, rice flour and kaolin as binding materials highlights the concept of sustainable art that supports environmental conservation efforts. These dyes do not contain harmful chemicals and are naturally biodegradable, making them a safer and more environmentally friendly alternative to synthetic dyes. Overall, the results of the study show that plant-based dyes are not only suitable for textile use, but also have great potential in the field of fine arts. This research opens up new avenues in the development of green art materials that maintain local identity while contributing to environmental sustainability.

https://doi.org/10.37134/kupasseni.vol14.sp.6.2026

Table 2. Colours produced when tested on drawing paper

SAMPLE	ROSELLE	*CLITORIA TENARTEA*	*CURCUMA LONGA*
Pigment + distilled water	 colour: Magenta	 colour: Sky blue	 colour: Yellow
Pigment + methanol	 colour: Magenta	 colour: Midnight blue	 colour: Gold
Pigment + kaolin + glycerin + Arabic gum + solvent	 Colour : Saddle brown	 Colour : Green	 colour: yellow
Pigment + rice flour + glycerin + Arabic gum	 Colour : Rosy brown	 Colour : Green	 colour: yellow

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CONCLUSIONS

Overall, this study has proven that local plants such as roselle, turmeric and telang flowers have great potential to be used as a source of natural dyes that are environmentally friendly, safe to use, and havehigh aesthetic value. The use of local materials not only saves costs and reduces dependence on synthetic materials, but also contributes to environmental sustainability and the preservation of local artistic heritage. It is hoped that this study can form the basis for further research in efforts to introduce art materials based on nature and local culture.

Suggestions for Further Research

For future research, several suggestions are put forward:

1. Study more types of local plants that have the potential to be sources of natural color pigments.
2. Conduct scientific analysis of the chemical composition of pigments to identify long-term stability and resistance to light and temperature.
3. Try various art mediums such as canvas, fabric, and ceramics to evaluate the suitability of pigments.
4. Incorporate modern technological innovations in the extraction process to improve the quality and durability of colors.

This further research is expected to strengthen the development of green art materials that support environmental sustainability and elevate the value of Malaysia's local plant heritage in the field of fine arts.

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CONFLICT OF INTEREST

"The authors declare no conflicts of interest" should be included if there is no conflict of interest.

AUTHORS CONTRIBUTION

All listed authors must have made a significant scientific contribution to the research in the manuscript, approved its claims, and agreed to be an author. It is important to list everyone who made a significant scientific contribution. Provide at minimum one contribution for each author in the manuscript and use the CRediT taxonomy to describe each contribution.

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Sample CRediT author statement: **Author 1.**: Conceptualization, Methodology, Software. **Author 2.**: Data curation, Writing- Original draft preparation. **Author 3.**: Visualization, Investigation. **Author 4.**: Supervision. **Author 5.**: Software, Validation. **Author 6.**: Writing- Reviewing and Editing.

AVAILABILITY OF DATA AND MATERIALS

Please choose one of the applicable statements below.

1. Data available within the article or its supplementary materials.

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During the preparation of this work, the author(s) used [ChatGPT] to enhance the clarity of the writing. After using the [ChatGPT], the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

ETHIC STATEMENTS

'Not applicable' in this section.

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