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Eco – colourants and Collage:
Exploring natural colours extracted from ketapang leaves

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Abstract
The application of synthetic colorants in visual arts can cause substantial risks to the health and well-being of artists. The hazardous compounds in some paintings, whether they are acrylics, oils or watercolors, can cause negative health and environmental consequences. This study aimed to produce artworks with eco-colourants extracted from ketapang leaves using the boiling water extraction method. The extraction was performed at a boil for 30 minutes in distilled water keeping the liquor ratio at 1:20. The pre-mordanted, as well as meta-mordanted cotton, linen, viscose and satin silk fabrics with 5 – 10% (owf) of alum and tunjung, were dipped in the eco-colourants extract solution for 30 minutes to complete the dyeing cycle. The liquor ratio used in dyeing procedures was 1:20 and 1:40. The dyed fabrics were then evaluated visually in terms of shades obtained and the applicability toward the production of collages. The interesting aspect of this study was that the application of different mordants gave a variety of hues, even though the extracted eco-colourants come from the same source. Generally, pre-treated fabrics with tunjung produced darker shades in comparison with alum. The collected information was analysed and successfully executed to produce final collage artworks. However, the effectiveness might depend on the skills, abilities, and knowledge to produce collage artwork products using dyed fabric with extracted eco-colourants from ketapang leaves. This study gives preliminary evidence that plant-derived eco-colourants can be used in the visual arts and that they should be investigated more in the future.

Keywords: *ketapang* leaves, eco-colorant, extraction, mordant, collage.

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1.0 Introduction
Natural dyes or eco-colourants have recently regained popularity among eco-conscious societies due to the increased awareness of the toxic and allergic reactions associated with synthetic colourants that have been mandated in several countries. Damjanović et al. (2015) stated that numerous colourants used in traditional paintings and pastels contain heavy metals, including antimony, barium, cadmium, chromium, cobalt, copper, lead, manganese, strontium and zinc. These metals are linked to various cancers, as well as diseases of the heart, kidneys, liver, lungs, and skin. Concerns about the health risks of the materials they were using grew among artists in the 1970s and 1980s. In 1988, Congress passed the Labeling of Hazardous Art Materials Act, which was an amendment to the Federal Hazardous Substances Act. It required manufacturers of arts and crafts materials to list ingredients that are known chronic hazards on the label with appropriate hazard warnings (Ashley, 2018). Due to this situation, the demand for eco-colourants has soared among artists and textiles dyers.

According to Toprak and Anis (2017), eco-friendly colourants have no waste to dispose of. Eco-colourants can be extracted from sustainable and renewable natural sources such as plants (e.g., indigo and woad); insects and invertebrates (e.g., cochineal, kermes, and

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some species of mollusks) as well as minerals (e.g., ferrous sulfate, ochre, and clay) without any or with very little chemical treatment (Yusuf et al., 2017). While according to Balagurunathan et al., (2011) and Wan Azlina et al., (2012) microorganisms such as bacteria, fungus, algae, and actinomycetes can also be used to produce eco-colourants.

As science and technology are revolutionizing, the entire world is becoming more vulnerable to a variety of environmental hazards. The dyeing of textile fabrics with eco-colourants has piqued the curiosity of many people because of their biodegradability and excellent compatibility with the environment from sustainable sources in line with the main pillars of the Sustainable Development Goals (SDGs) (United Nations Development Program, 2019). The development of eco-colourants is critical to the concept of sustainability, as natural colours derived from natural sources such as plants, insects, and minerals are both sustainable and environmentally benign.

Textile art is a broad term that can encompass many types of approaches such as the techniques of weaving, knitting, tufting, printing, dyeing and embroidery as well as quilt and collage (Barnes, 2017). Products made of textiles are frequently connected with fabrics, which can be used in a variety of contexts including fashion, interior design, architecture, automobiles as well as health and wellness.

2.0 Literature Review

2.1 Overview of Eco-colourants from *Ketapang* Leaves

Ketapang tree also known as tropical almond (Terminalia Catappa Linn) is a large, spreading tree distributed throughout the tropics in coastal environments for shade, ornamental purposes, and edible nuts (Akpakpan and Akpabio 2012). *Ketapang* tree spread to almost all regions in Southeast Asia, including Malaysia. The leaves change their colour from green to red, yellow, or gold and copper brown during the dry season and then they fell off.

. Several pieces of research have been conducted to utilize the *ketapang* leaves as a source of eco- colourants for textiles dyeing. Kasembunyakorn et al. (2012) investigated the effect of tannin as a mordant on dyed silk fabric with tropical almond leaves extracts. Four types of mordant (tannin) derived from cassava leaves, copper sulphate, potassium dichromate, and potassium aluminium sulphate at 5% concentration were used. The result revealed that the types of mordant had an effect on colour values at the significant level of 0.05 as well as increased lightness (L*). The total colour difference (dE*) was examined to study colourfastness to laundering of the dyed fabrics. The result revealed that the types of mordant influenced the colour change but did not on colour staining at the significant level of 0.05. As a result, tannin can be employed as a mordant to further increase the quality of dyeing silk with eco-colourants.

While Vadwala and Kola (2017) successfully dyed nylon fabric with eco-colourant extracted from the waste of *ketapang* leaves. Prior to the dyeing process, nylon fabrics were pre-mordanted with 10% of natural mordants such as tannic acid and acetic acid as well as chemical mordants such as iron and copper sulphate for 30 minutes at room temperature. The dyeing was performed on pre-mordanted nylon fabrics at 85 – 90^{0}C for 25 – 30 minutes. The dyed nylon fabrics were then evaluated in terms of shades obtained and fastness properties. The findings concluded that eco-colourants from *ketapang* leaves produced different shades of dyed nylon fabrics depending on the mordants used with excellent fastness properties.

Extraction of natural dye from *ketapang* leaves for colouring textile materials was conducted by Faisal and Chafidz (2019). *Ketapang* leaves were macerated in distilled water for 4, 6, and 8 days to complete the extraction procedures. Extracted tannin was then used to dye cotton fabric by immersing the cotton fabrics in the tannin solution for 60 minutes. Post-mordanting technique with 50g/L of three different mordants i.e. alum, *kapur tohor,* and *tunjung* was executed for 60 minutes on the pre-dyed cotton fabrics. The washing and rubbing fastness properties of the specimens were evaluated. The results showed that the fabric mordanted with alum exhibited the optimum result for fastness tests.

Sintha et al (2020) successfully extracted tannin from *ketapang* leaves using solvent extraction procedures. The extraction was conducted for 30, 60, 90, 120, and 150 minutes using different concentrations of ethanol as a solvent varying from 60, 70, 80, 85, and 90% at pre-determined temperature i.e. 85^{0}C, and stirred at 200 rpm. The finding revealed that 85% ethanol for 120 minutes produced a higher yield (98.97%) of tannin.

2.2 Collages

Collage, which comes from the French verb "coller" (to stick), is a way to show things by glueing together small pieces of found images or materials and putting them on a flat surface (Butler-Kisber and Poldma, 2010). While according to Cambridge Advanced Learner's Dictionary & Thesaurus (2020) collage is the art of making a picture in which various materials or objects such as papers, clothes, or photographs are stuck onto a larger surface. Fabric collage, on the other hand, is defined as a revolutionary way of quilting that allows every textile artist to express their own particular creativity while also learning cutting-edge stitching methods at the same time (Eichorn, 2003). The fabric used for the collage can consist of used clothes or new fabric that is dyed, cut, and glued to the backing materials.

The art of collage has been around for a long time. Over a thousand years ago, Japanese calligraphers and painters used collage to enrich their poetry. According to Butler-Kisber and Poldma (2010), in the early 20th century, the "fathers" of collage (Picasso and Braque) employed collage to challenge the representational demands of formalist painting. This is when collage really came into its own. Indeed, "collage represents the way we see the world, with objects deriving their meaning not from something intrinsic to them, but rather from our perception of their relationship to one another" (Robertson, 2002). Furthermore, because the fundamental skills of cutting and sticking are learned early in life and become part of everyone's repertory, collage can be done by beginners while gaining increasingly sophisticated aesthetic and compositional expertise (Butler-Kisber and Poldma, 2010).

3.0 Methodology

3.1 Materials

The source of eco-colourants used in this study was *ketapang* leaves found around the district of Rawang. The mordants used were alum ($Al_2(SO_4)_3$, and *tunjung* ($FeSO_4$). The fabrics used were woven silk with satin weave structure as well as plain cotton, linen, and viscose rayon woven fabrics.

3.2 Extraction of Eco-colourants from *Ketapang* Leaves

Dried *ketapang* leaves were chopped into small pieces and ground into a fine powder with a domestic blender. The dried *ketapang* leaves powder was placed inside a beaker containing distilled water and boiled for 30 minutes. The extraction was executed at the liquor ratio of 1:20. The mixture was then sieved to remove solid *ketapang* leaves powder.

3.3 Mordanting

Two mordanting techniques were carried out in this study i.e. pre-mordanting and meta-mordanting (simultaneous mordanting). The concentrations of mordants used were 5 and 10% (owf) based on the weight of fabrics used keeping the liquor ratio at 1:20. For the pre-mordanting technique, the fabrics were boiled in a mordant solution for 30 minutes followed by drying under direct sunlight. While for meta-mordanting, the dyeing and mordanting were executed simultaneously keeping the same parameters as pre-mordanting.

3.4 Dyeing

The dyeing was performed on both pre-mordanted fabrics as well as simultaneously with meta-mordanted fabrics. The liquor ratio used was maintained at 1:20 and the dyeing was executed at a boil for 30 minutes. However, to obtain lighter shades, a liquor ratio of 1: 40 was applied. Once the dyeing cycle was completed, the dyed fabrics were dried under direct sunlight.

4.0 Findings

4.1 Shades of the Dyed Fabrics

The eco-colourants extracted from the *ketapang* leaves were brownish in colour, indicates that the presence of tannin as the main pigment compound. However, mordanted fabrics with *tunjung* gave a black color. Alum produced lighter shades because alum is known as brightening mordants while *tunjung* produced darker shades as *tunjung* is known as dulling mordants (Samanta and Konar, 2011). The polygenetic properties found in eco-colourants from *ketapang* leaves cause the resulting colour to change according to the mordant used as shown in Tables 4.1 and 4.2 (pre-mordanting) and Tables 4.3 and 4.4 (meta-mordanting).

Table 4.1: Swatches of Pre-mordanted Dyed Fabrics with Alum

Fabric	Water (ml)	Mordant (gm)	Dye (ml)	Fabric Weight (gm)	Result
Satin Silk (30 mins boiled)	1956	9.78 (10% owf)	1956	97.9	
Cotton (30 mins boiled)	2938	14.69 (10% owf)	2938	146.9	
Linen (30 mins boiled)	2958	14.79 (10% owf)	2958	147.9	
Viscose (30 mins boiled)	3470	17.35 (10% owf)	3470	173.5	

Table 4.2: Swatches of Meta-mordanted Dyed Fabrics with Tunjung

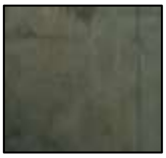
Fabric	Dyes (ml)	Mordant (gm)	Water (ml)	Fabric Weight (gm)	Result
Satin Silk (30 mins boiled)	920	4.6 (10% owf)	920	46	
Cotton (30 mins boiled)	2822	14.11 (10% owf)	2822	141.1	
Linen (30 mins boiled)	3022	15.01 (10% owf)	3022	150.1	
Viscose (30 mins boiled)	3848	19.24 (10% owf)	3848	192.4	

Table 4.3: Swatches of Meta-mordanted Dyed Cotton Fabrics with Different Liquor Ratio

Fabric	Dyes (ml)	Mordant (gm)	Water (ml)	Fabric Weight (gm)	Result
Cotton (boiled for 30 mins)	2898 LR: 1:40ml	14.49 (10% owf)	2898	144.9	
Cotton (boiled for 30 mins)	2470 LR: 1:20ml	6.17 (5% owf)	2470	123.5	

Table 4.4: Swatches of Meta-mordanted Dyed Cotton Fabrics with Different Liquor Ratio

Fabric	Dyes (ml)	Mordant (gm)	Water (ml)	Fabric Weight (gm)	Result
Cotton (boiled for 30 mins)	3098 LR: 1:40ml	15.49 (10% owf)	3098	154.9	

Cotton (boiled for 30 mins)	2670 LR: 1:40ml	6.67 (5% owf)	2670	133.5	
Cotton (boiled for 30 mins)	2432 LR: 1:40ml	4.86 (4% owf)	2432	121.6	
Cotton (boiled for 20 mins)	1986 LR: 1:40ml	3.9 (4% owf)	1986	99.3	

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4.1 Application of Dyed Fabrics in Collage

Figure 4.1 shows the collage produced by cutting, arranging, and sticking the dyed fabrics with eco-colourants extracted from *ketapang* leaves. In order to obtain different effects and shades, different fabrics were used together.

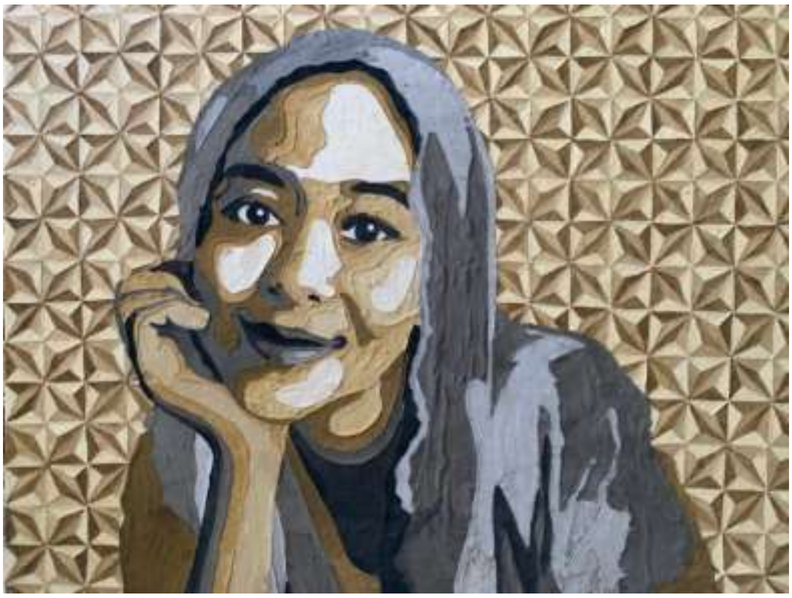

Figure 4.1: Collage from Dyed fabrics with Eco-colourants Extracted from Ketapang Leaves.

5.0 Conclusion

Eco-colourants containing tannin were successfully extracted from *ketapang* leaves using the boiling water extraction method in conjunction with pre- and meta-mordanting techniques. The different shades obtained on the dyed silk (satin), cotton, linen, and viscose rayon with different mordant and liquor ratios were well arranged and found suitable to be used as a medium to produce a collage.

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References

Akpakpan AE, Akpabio UD. 2012. Evaluation of proximate composition, mineral element and anti-nutrient in almond (*Terminalia catappa*) seeds. Res J Appl Sci 7 (9-12): 489-493.

Ashley, E. (2018). Art Hygiene Law: Artists Who Use Unusual Materials and Viewers Who "Take In" The Art. Center for Art Law. Retrieved on 20 Dec 2021 from https://itsartlaw.org/2018/07/05/art-hygiene-law-artists-who-use-unusual-materials-and-viewers-who-take-in-the-art/

Barnes, S. (2017). Art History: Ancient Practice of Textile Art and How It Continues to Reinvent Itself. My Modern Met. Retrieved on 20 Dec 2020 from https://mymodernmet.com/contemporary-textile-art-history/

Butler-Kisber, L., & Poldma, T. (2010). The Power of Visual Approaches in Qualitative Inquiry: The Use of Collage Making and Concept Mapping in Experiential Research. *Journal of Research Practice*. 6(2). 1 – 16.

Cambridge Advanced Learner's Dictionary & Thesaurus (2020). Cambridge Advanced Learner's Dictionary & Thesaurus. Cambridge: Cambridge University Press. https://dictionary.cambridge.org/dictionary/english/collage

Damjanović, Lj., Gajić-Kvaščev, M., Đurđević, J., Andrić, V., Marić-Stojanović, M., Lazić, T. & Nikolić, S. (2015). The characterization of canvas painting by the Serbian artist Milo Milunović using X-ray fluorescence micro-Raman and FTIR spectroscopy. *Radiation Physics and Chemistry*. 115, 135 – 142. http://dx.doi.org/10.1016/j.radphyschem.2015.06.017

Eichorn, R. (2003). *The Art of Fabric Collage: An Easy Introduction to Creative Sewing*. USA, Taunton Press.

Faisal, R.M. & Chafidz, A. (2018). Extraction of Natural Dye from Ketapang Leaf (Terminalia catappa) for Coloring Textile Materials. *1st International Symposium of Indonesian Chemical Engineering (ISIChem) 2018*. 543(2019) 012074. DOI:10.1088/1757-899X/543/1/012074.

Kasembunyakorn, S., Pornsuda, M. & Arirob, W. (2012). Effect of Tannin Mordant on Silk Dyed with Tropical Almond Leaves (TERMINALIA CATAPPA LINN.). *Journal of ARAHE*. 19. 174 – 177.

Kumar R, Ramratan, Kumar A & Uttam, D. (2017). To Study Natural Herbal Dyes on Cotton Fabric To Improving The Colour Fastness and Absorbency Performance. *Journal of Textile Engineering and Fashion Technology*. 7(2), 51 – 56. DOI: 10.15406/jteft.2021.07.00267

Robertson, B. (2002). *Why collage?* Unpublished manuscript.

Samanta, A.K., and Konar, A. (2011). Dyeing of Textiles with Natural Dyes. In Kumbasar, E.P.A. (Ed.), *Natural Dyes* (29 - 56). Croatia, InTech.

Sintha, S.S., Febriana, I. & Nita, M. (2020). Extraction of Tannin from Ketapang Leaves (*Terminalia catappa* Linn). 1st International Conference Eco-Innovation in Science, Engineering, and Technology. 196 – 199. DOI: 10.11594/ nstp.2020.0530

Toprak T. & Anis P. (2017). Textile Industry's Environmental Effects and Approaching Cleaner Production and Sustainability, An Overview. *Journal of Textile Engineering and Fashion Technology*.2(4), 429 – 442. DOI: 10.15406/jteft.2017.02.00066

United Nations Development Program, 2019. Sustainable Development Goals. Retrieved on 12th Nov. 2019 from https://www.my.undp.org/content/malaysia/en/home/sustainable-development-goals.html

Vadwala, Y. & Kola, N. (2017). Dyeing of Nylon Fabric with Natural Dye Extracted from Waste Leaves of *Terminalia Catappa* Locally Known as Tropical Almond Tree. *International Journal of Home Science*.3(2). 175 – 18.

Yusuf, M., Shabbir, M. & Mohammad, F. (2017). Natural Colorants: Historical, Processing and Sustainable Prospects. *Natural Products and Bioprospecting*. 7(1). 123 – 145. DOI: 10.1007/s13659-017-0119-9