

INTEGRATING SCIENTIFIC ANALYSIS IN THE SECOND-YEAR STUDIO PROJECT FOR CRAFT PRODUCT USING HANDMADE PAPER

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ABSTRACT

The use of the plant-based fibre in the production of handmade paper for craft product was little explored through scientific research. Handmade paper has different rates of expansion and contraction, strength, absorbency, stability and rigidity, which can be examined through scientific analysis. Thus, with these physical properties, the handmade paper is a potential material for making a variety of craft objects. Their shapes and colours could complement any kind of objects which can be made in multitudes of options. Therefore, this paper aims to highlight the analysis of the handmade paper in the making of craft object for the second-year studio project of Applied Arts and Design programme, specifically for conservation major. The objectives of the analysis are: to examine the potentiality of various plant-fibres as raw materials for handmade paper and to analyse the compatibility of the plant-fibre papers for making of a craft product. In accomplishing these objectives, first, the handmade papers were produced from 7 types of fibres by applying the technique of Nagashizuki sheet formation. The research used fibres of bamboo, kenaf, banana, Etlingera elatior, lemon grass, corn and pineapple to make the papers. Then, an experiment was conducted to test the mechanical and physical properties of the papers. Fibre structure identification was done to determine the potentiality of the paper to be used as eco-material for craft product. The analysis of the 7 plant fibres showed that they are good raw material for papermaking and the different fibres yield to different paper quality for various craft application. The students also analysed physical properties of the paper including tensile strength and tactile texture and found that they are very suitable for making crafts. The research found that all handmade papers from the 7 selected fibres show some differences in their physical properties and each paper has distinctive physical quality. Among the 7 types of handmade paper, only papers form fibres of bamboo, kenaf and banana have more refined and smooth texture, strength and rigidity. Based on these findings, further analysis is required to prove the durability of the paper, and it can be accepted as a sustainable material for the various application in the craft production.

Keywords Plant fibre, handmade paper, Nagashizuki method, studio project, sustainable material

INTRODUCTION

There are plenty alternative sources of fiber from tropical plants which are potential for paper production. The tropical plants, for examples, bamboo (Bambusoideae), kenaf (Hibiscus Cannabinus), and banana (Musa) are suitable for production of handmade paper and other eco-friendly products. Bamboo, for example, is also commonly used in Asian countries for textile, home accessories and furniture. According to Shih-Hsing and Ming-Chyuan Ho (2015), fibre dimension, lignin and cellulosic content of bamboo determine their suitability for paper production. Likewise, there are some alternative plants that have the same physical characteristics which are suitable for paper production. Hence, the use of these plants for handmade paper production should be explored for alternative fiber sources. Handmade paper from the plant fibres has different physical characteristics including opacity, brightness, strength and texture. In addition, Hubbe and Bowden (2009) posits that long plant fibres have potentiality to achieve high tensile strength and high tearing resistance. Thus, with these physical properties, the handmade paper is potential material for making a variety of craft objects. Their shapes and colours could complement any kind of objects which can be made in multitudes of options. Therefore, this paper aims to highlight the analysis of the handmade paper in the making of craft object for the second-year studio project of Applied Arts and Design programme at the department of Applied Arts and Design, Kulliyah of Architecture and Environmental Design. The aim of the project was to explore the potentiality of the plant fibres in the making of handmade paper for the craft object. Most paper made today comes from automated and mass production system, which gives it homogenous quality. Unlike the machine-made paper, handmade paper has different characteristics because of the different fibres originated from plants. Traditional handmade paper involve cellulosic fibres could help in modern applications (Hubbe and Bowden; 2009). Furthermore, the use of handmade paper as prime materials for the studio project is bound to save a few extra ringgits on production. Also, the students can customise their products according to the quality of the paper, however the potentiality of the handmade paper and its compatibility for the craft production are yet to be determined first through scientific research. Therefore, the objectives of the research are: 1) to examine the potentiality of plant-fibre as raw material for handmade paper, and 2) to analyse the compatibility of the plant-fibre paper for making of craft product. The use of the plant-based fibres for handmade paper have been widely practiced, however the scientific analysis of the fibre-based paper was little explored, especially its compatibility for craft production. Although many researches on handmade papers and its outcomes have been receiving increased attention in recent decades (e.g. Nurdiah Bidin et al., 2015; Arafat et al., 2018; Rahman et al., 2014; Mossello et al., 2010), little research has been done to identify and analyse specific local plant fibres to make handmade paper for craft products. Furthermore, the use of the plant-based fibres for handmade paper was little explored through scientific research. It is important to identify the physical characteristics of plant fibre because different fibre has different opacity, strength and texture, which can be examined and determined through laboratory procedure. According to Shih-Hsing and Ming-Chyuan Ho (2015), there are many available plant species for pulping which can be divided into different classes based on quality for paper making, however their physical quality can be determined through experiment.

HISTORY AND DEVELOPMENT OF HANDMADE PAPER

The production of hand-made paper is a traditional technology that has been practiced for hundreds of years. It is generally believed that paper was invented in China at the beginning of the 2nd century (IAMM, 2009). The Chinese Emperor, Tsai Lun had invented paper in the year 105. This illustrates that handmade paper has a long history in China. Then, the invention spread to the different parts of the world including to Japan, India and the Islamic world. Hubbe and Browden (2009) states that the main sources of cellulosic fiber evolved as the ancient craft migrated from its birthplace in China to Korea and Japan, the Islamic world, and then to Europe and America. Paper is manufactured from cellulose-based vegetable fibres including wood, cotton, linen, grass, straw and hemp (Hubbe and Browden, 2009). The natives in Sichuan, Fujian, Shanzhou and Zhejiang used jute, fresh bamboo, liana and wheat or rice straw to make paper (Shih-Hsing and Ming-Chyuan Ho, 2015). Most of the mills for the handmade paper manufacture are cottage and small-scale enterprises. In recent years, many small-scale enterprises in the region keep their traditional practices of paper production.

TRADITIONAL HANDMADE PAPERS: MATERIAL SOURCES AND PHYSICAL PROPERTIES

The term 'paper' refers to a thin material or a sheet that is produced by pressing together moist fibres (Turner and Skiold, 1983). Whereas, handmade paper is a sheet of paper that has layers of entwined fibres and made by hand using specific method and techniques of formation. In general, paper is vulnerable to possible physical damage that can be incurred includes abrasion, tearing, creasing, buckling and staining of the substrate (IAMM, 2009). Traditional papers made by hands come from a wide range of fibre plants with different physical and chemical properties. Many types of plant fibres are suitable to make an incredible range of handmade papers. These include bamboo, banana, mulberry, and cotton. A study by Arafat et al. (2018) suggests waste banana fibre is suitable raw material to produce handmade paper because the fibre has long fibre length. Fibres are important cells for pulping and paper making (Turner and Skiold, 1983; Olotuah, 2006, Rahman et al., 2014).

The fibres from other types of plants also have suitable raw material for handmade paper. Daniel Sekyere, (1994) had conducted a study on bamboo and discovered that bamboo is good source of raw material for pulp and paper. It is known that bamboo trees are among the fastest-growing plants in the world, thus the fibre for handmade paper from this plant is more sustainable. In Japan, the symbolism of the bamboo plant runs deep and wide and offers practical lessons for life and for work (Hori, 1991). A wide range of Japanese handmade papers come from bamboo fibres. China has a great number of enclaves, which have coverage with bamboo forest, for example, in Wenzhou, Zhejiang province (Hubbe and Browden, 2009). In this province, villagers make papers using a bamboo curtain model. They dip a bamboo curtain model in and out of a sink filled with bamboo pulp. Then the pulp forms sheets of paper on the model and this work can be repeated to get more sheets. In short, it involves art, science and technology in the making process of handmade paper. The appropriate use of materials, equipment and methods of production are the key elements in the handmade paper making process.

METHOD AND TECHNIQUE: JAPANESE NAGASHIZUKI SHEET FORMATION

Sheet formation is a process in which a property of a sheet is based on the overall uniformity of the fibre distribution in the sheet. According to Hubbe and Browden (2009), sheet formation is important in the handmade paper production process because it affects both the appearance and performance of paper product. Japanese and Chinese have developed different methods of traditional papers made by hands. One of the methods is 'Nagashizuki', which is the traditional practice of Japanese paper making (Barrette, 2005). This Japanese word comes from the verb 'nagasu' which means 'to flow or slosh' and 'suku' means 'to make paper'. In order to form a sheet, papermakers usually dip a screen into a vat and swish the fibres and water back and forth across the screen in waves. Turner and Skiold (1983) explain that the papermakers usually place a mould or screen vertically and dip the mould horizontally into the vat to pick up just enough fibres to form initial thin layer of paper. The makers continue by letting the waves of pulp pass either front to back or side to side across the screen several times. Eventually, the layer of fibres is gradually deposited on the screen. This method of paper formation has been passed down for many generations within the families of papermakers and has become of their cultural significances.



Figure 1: A villager dips a bamboo screen in and out of a vat filled with bamboo pulp to form sheets of paper on the screen.

Source: (<http://www.fibre2fashion.com>, 2017)

THE APPLIED ART AND DESIGN STUDIO PROJECT AND ITS LEARNING METHOD

In the second year of study, the learning outcome of the conservation project for the Applied Arts and Design studio is to apply basic knowledge of conservation studies particularly pertaining to the organic materials and techniques. The focus of the studio was on paper-based materials and techniques. Therefore, in line with this study focus, the aim of the studio project was to explore the potentiality of the plant fibre in the making of handmade paper for the craft object. Students should be able to produce the handmade paper from plant fibres for an appropriate use. They are required to design and produce handmade paper craft products, for examples, wall clock, wall screen and book cover using suitable handmade papers. Traditional papers made by hands would come from a wide range of fibre plants with different physical and chemical properties. The important properties of this paper are judged on its colour, opaqueness, smoothness, surface texture, stiffness or limpness. The handmade paper objects can be made in a variety of shapes and colours that complement any kind of craft product and the students can make these objects in multitudes of options.

Inasmuch, the making of fibre-based handmade paper is all-embracing and bind to the full understanding of production method, sensibilities of materials and handling of techniques during the making process (Daniel, 1994). This would lead to the craft production with high technical and aesthetic values. Understanding of the fibre paper including the process of the making would be expansively achieved through laboratory test apart from doing background research. In making the handmade paper out of the plant fibres, the scientific analysis concentrated towards experiment with samples of plant fibres is vital that can provide the students with opportunity to explore them for handmade paper through laboratory test. Also, this learning process allows students to analyse each sheet of paper using lab instruments in order to determine its suitability for making of craft product.

METHOD OF SHEET FORMATION AND SCIENTIFIC ANALYSIS

The project begins with reviews of related researches and literatures and research issues pertaining to the handmade paper in relation to its material properties, sustainability issues, and the methods and techniques of production. In order to achieve the aim and objective of the studio project, which is to determine the physical and chemical properties of the handmade papers from different plant fibres, the students had adopted an experimental procedure for data collection including scientific analyses that were conducted in different stages. First, the pH test was done to measure the acidity and alkalinity of the handmade papers. Then, the analysis of the handpaper specimens using magnification hand lens method was conducted to determine the characteristics and physical properties of the papers. A folding endurance test also was conducted to measure the amount of tensile strength and stretch properties of the papers. Last, the colour compatibility test was done on the pulps of different fibres to test its compatibility with synthetic dyes by looking at the absorbency of the dyes. The students had conducted the whole process of scientific analysis in the conservation laboratory. Prior to the scientific analysis, the students had produced handmade papers from 7 different types of plant fibres using the Japanese Nagashizuki sheet formation. The fibre materials were from bamboo stems, banana trunk, kenaf stems, pineapple leaves, ginger flower stems, corn husks and lemon grass stems to extract their fibres. The method of Japanese Nagashizuki sheet formation was repeated for each type of fibres. In this process, an expert person in the handmade paper from Kedah was consulted to obtain information on the papermaking process. He has been involved in the handmade paper industry for the past 15 years and he is still active in the production of handmade paper using a traditional method.

The process of extracting fibres from bamboo plant was not as easy as extracting fibres from other types of plant. A special cutting tool as shown in Figure 2 was used to divide the bamboo stem into long strips first, before extracting bamboo fibres from the inner part using a utility knife as shown in Figure 3. The bamboo fibre is naturally smooth and round, hence, extracting of the fibre from the bamboo strips is not hard. The bamboo fibres can produce starchy pulp and it has versatile properties, soft, smooth and with shiny appearance. Kenaf and banana fibres also have versatile properties with soft and smooth appearances.



Figure 2: Cutting bamboo into long strips before extraction of fibres



Figure 3: Extracting of fibres from bamboo strips using a utility knife

Once the process of extracting fibre from the bamboo finished, the next step involved the use of a plastic container to soak the fibre for a few days before boiling it in a pot (Fig. 4). It took 9 to 12 hours to boil the fibre until reaching the right consistency of pulps. 1 tablespoon of non-caustic alkali (Soda ash) was added to each quart of water. The use of soda ash fastens the boiling process in obtaining starchy, soft and mushy pulp, as the cooking can break down the fibres and separate the cellulous from other plant tissues.

After boiling, the pulp was pounded before pouring into a vat that contains clean water. In this process, a small amount of natural substance, known as vegetable mucilage to serve as a viscous solution was added into the vat. Mucilage is used to keep the paper fibres evenly suspended in the water during the sheet formation. Thus, as a formation agent, the mucilage helps to form a uniform and good quality paper. As Hubbe and Bowden (2009) emphasise that mucilaginous compounds extracted from plant roots can improve the dispersity of the fibres during the sheet formation as practiced by the Japanesse traditional handmade papermakers. They have been able to develop a thin and strong sheet of paper through this special way.



Figure 4: Soaking of bamboo fibres before boiling (left) and boiling the fibres before beating (right)

In the process of sheet formation, the students used a screen (Fig. 5A) to form the sheet or paper. The screen was immersed horizontally into a vessel to pick up just enough pulps to form a thin layer of paper. The property of a sheet is based on the overall uniformity of the fibre distribution in the screen. The sheet formation is important in the handmade papermaking because it affects both the appearance and performance of paper product (Hubbe and Browden; 2009). The process of sheet formation was accomplished through the method of Japanese Nagashizuki sheet formation., which is practical for the handmade papermaking. In order to remove excess water from a sheet, the students gently pressed a clean sponge across the thin layer of a sheet as shown in Figure 5B. Removing of excess water from the sheet is necessary to allow the paper to be handled easily and placed at the metallic surface for natural drying (Fig. 5C). In addition, pressing forces the cellulose fibre of the paper to bond with themselves forming a strong sheet.



Figure 5: Straining the pulp to form a sheet (A), using sponge to remove excess water from the sheet (B) and drying of the sheets on a flat surface

Figure 6 shows the analysis of the specimens using magnification hand lens method. The analysis was conducted to determine the characteristics and physical properties of the papers and to characterize them according to their physical properties, namely brightness, opaqueness, smoothness, surface texture, and stiffness. Apart from these, the characterization of each fibre was possible to identify their length, strength and rigidity. Identification of these properties for each specimen in details was possible via the use of the hand lens. Subsequence to the analysis, the students had performed series of scientific test on the specimens, namely Ph test, folding endurance test, and colour compatibility test. These are basic tests for handmade paper apart from performing the physical test on the fibre structure.



Figure 6: Identification of physical properties for each specimen using 10x magnification hand lens

ANALYSIS OF HANDMADE PAPERS FROM PLANT-FIBRES AS RAW MATERIALS

The first objective of the research for the studio project was to examine the potentiality of plant-fibres as raw materials for handmade paper. In line with this objective, the analysis involved the use of 7 different types of plant fibres to make a range of handmade papers as testing specimens. These include the bamboo culms, banana trunk, kenaf stems, pineapple leaves, ginger flower stems, corn husks and lemon grass stems are among the selected types of plant fibres. By becoming familiar with the nature of the handmade paper and the fibres as material from which they are made, it is apparent that there are various physical distinctions between the samples as highlighted in Table 1. The specimen of bamboo paper, for example, as shown in Figure 7 was a result of sheet formation through the use of soft and mushy bamboo fibre. This paper has a smooth surface with gleaming quality. Each plant fibre has its distinctive qualities and all of them are suitable for handmade papermaking.

Table 1: Different types of plant fibres and its physical qualities

Sample of handmade paper	Type of Fibre	Description of physical qualities
SAMPLE 1	Bamboo fibre	The paper has soft sheet, dense, smooth with gleaming qualities give smooth texture. The fibre is characterized by fine-grained, soft, pliant, and lustrous fibres, thus making the paper solid, especially after applying the sizing and furnishing.
SAMPLE 2	Banana fibre	The paper has soft sheet, dense and murky colour, smooth with lustrous qualities and shows smooth texture. The fibre is characterized by fine-grained, soft, pliant, and lustrous appearance, thus making the paper solid but thin, especially after applying the sizing and furnishing.
SAMPLE 3	Kenaf fibre	The paper has soft sheet, less opacity, light colour, smooth with lustrous qualities and shows smooth texture. The fibre is characterized by strong, sinewy and long, thus making the paper strong, especially after applying the sizing and furnishing.
SAMPLE 4	Pineapple fibre	The paper has stiff sheet, dense and murky colour, coarse with lusterless qualities and shows uneven texture. The fibre is characterized by strong, sinewy and long, thus making the paper strong, especially after applying the sizing and furnishing.
SAMPLE 5	Corn fibre	The paper has stiff sheet, dense and light colour, coarse with lusterless qualities and shows uneven texture. The fibre is characterized by solid, sinewy and short, thus making the paper less strong, sizing and furnishing improves the surface and strength of the paper.
SAMPLE 6	Etlingera elatior fibre	The paper has stiff sheet, dense and light colour, lusterless qualities and shows bristly uneven texture. The fibre is characterized by hard, sinewy and long, thus making the paper strong, sizing and furnishing improves the surface of the paper.
SAMPLE 7	Lemon grass fibre	The paper has stiff sheet, dense and light colour, lusterless qualities and shows uneven texture. The fibre is characterized by solid, sinewy and long, thus making the paper strong, sizing and furnishing improves the surface of the paper.

The bamboo culms, banana trunk, kenaf stems, pineapple leaves, ginger flower stems, corn husks and lemon grass stems are among the many available plant species with suitable fibres for handmade papermaking. In this case, the production process and sheet formation depend on the quality and variety of the fibres used. Complexity in the paper production process is unescapable since most of the works was done manually and overwhelmingly time consuming. In this process, the students had to repeat the same method of sheet formation for each type of plant fibres.

The samples from the analysis are indicators that several aspects can influence the outcomes of handmade paper. In the case of bamboo papers shown in Figure 7, the sample on the left (A) has more refined surface texture, meanwhile, the sample on the right (B) has coarse surface texture. This is because the sample A was made from bamboo fibre that has been rigorously pounded and beaten to become pulps. Then, the mucilage was added to thicken the mixture and to slow down the draining of water from the screen. Thus, it helped to form a uniform layer of a sheet. In addition, surface sizing solution was applied to the pulp during the paper making process to provide water resistance. As a result, the sized handmade paper does not soak anything from liquid. Meanwhile, the sample B was formed without heavy beating, adding the mucilage and surface sizing and furnishing. Furnishing is a polishing technique done after sizing with a cowrie shell to flatten and smoothen the sheet. This technique helps to improve the paper surface.

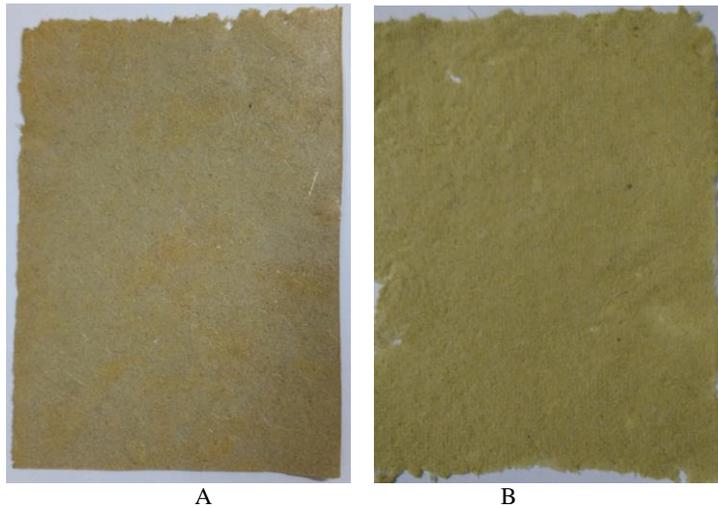


Figure 7: Bamboo samples with distinction of physical properties after sizing and furnishing

The results indicate that the texture of pulp, the use of mucilage, sizing and furnishing determine the outcome of the paper. Series of experiment done through this study were advantageous to produce a good handmade paper. Also, the results show that the types of plant fibre become one of the influencing factors for the outcome and quality of handmade paper. The paper formation has been shaped by the structure and physical properties of the plant fibres. In Kenaf paper and banana paper as shown in Figure 8, for examples, their fibres are characterized by strong, sinewy and long, thus making the sheet strong. The papers are soft and smooth but with less opacity and lustrous colour reinforced with glossy qualities and refined texture. The kenaf paper, however, has a higher degree of brightness and smoothness as compared to the banana paper as apparent in the figure 8.



Figure 8: Samples of Kenaf paper (left) and banana papers (right) with identical physical properties

The first objective of the research for the studio project was to examine the potentiality of plant-fibre as a raw material for handmade paper. The students have learnt that handmade paper is an organic material that is potentially made from cellulose-based plant fibres including bamboo, banana, kenaf, pineapple and corn. These fibres have different physical properties which can influence the quality of handmade paper. Therefore, each paper has different rates of brightness, strength, absorbency, stability and rigidity. This suggests that the various plant fibres are suitable materials for making handmade paper with different ranges of quality as explored through the scientific analysis. The analysis of the 7 types of handmade paper samples show some differences in their physical properties. The research found that all of the selected plant fibres are suitable materials to make the handmade papers, however each paper has distinctive physical quality. Among the 7 types of handmade paper, only papers from fibres of bamboo, kenaf and banana have refined and smooth texture, strength and rigidity. The finding suggests that the bamboo, kenaf and banana fibres are good materials for papermaking because of their applicable physical qualities.

THE pH TEST

The pH test is one of the methods to measure the acidity and alkalinity of the handmade papers. The use of pH meter, an electronic meter, during the analysis helped to determine the pH value of the papers. The pH level was taken in three readings in order to get the average result. The results show that the average of pH level of the papers ranging from 7.70 to 7.86 and these readings are considered as weak alkaline. This suggests that the fibre-based papers are all weak in alkaline level and they are acid-free papers, which means that they are more environmentally sound. Also, the advantages of these papers are; enhanced brightness, whiteness, and opacity.

Meanwhile, the results on folding endurance test show that the bamboo, kenaf and banana papers has the highest consistency to face the tension as compared to other papers. This shows that these papers have more strength than other papers. Daniel Sekyere (1994) has discovered in his research that bamboo has strong fibres for pulp and handmade paper. As noted by Hubbe and

Bowden (2009), when the fibres are beaten, the rectangular cross-section of fibres tends to become flatten and resulting ribbon-like shape leading to higher strength of paper structure. In the case of the colour compatibility test, the pulps of different fibres were used to test its compatibility with synthetic dyes. All fibres are found to be well satisfactory in the absorbency of the dyes. As an example, the colour pigments fixed completely on the substrate of bamboo fibre as appeared in Figure 9. Bamboo paper takes up the dye colours easier as compared to other papers. As noted by Sameen et al. (2014), bamboo fibre has various micro-gaps, which make it softer than cotton and increases its moisture absorption.



Figure 9: Bamboo paper samples show good absorbency of synthetic dyes

THE COMPATIBILITY OF THE PLANT-FIBRE PAPER FOR CRAFT PRODUCT

Traditional papers made by hands usually come from a wide range of fibre plants with different physical and chemical properties. The important properties of this paper are judged on its colour, opaqueness, smoothness, surface texture, stiffness or limpness. Handmade paper usually has different rates of expansion and contraction, strength, absorbency, stability and rigidity (IAMM, 2009). These physical characteristics of the paper can determine the value and visual quality of craft products. Handmade paper objects are made in a variety of shapes and colours that complement any kind of craft and these objects are made in multitudes of options. At the second phase of the studio learning process, the students were required to select the suitable handmade papers to produce their crafts. Among the products, a few lantern designs have been developed with suitable handmade papers by the students. As examples, the paper lanterns made from bamboo fibres and ginger flower fibres as shown in Figure 10 have distinctive visual qualities due to its textural and colour compatibility and strength, which complement the structural form of the lanterns. In harmony with the concept of the lanterns, the bamboo paper and ginger flower paper have visual qualities of long fibres and high absorbency of colour that make it compatible for the lantern products. It is apparent that the lantern made from fibre of *Etingera elatior* or ginger flower shows equally compatible but with less absorbency of colour pigments as compared to bamboo lantern.



Figure 10: Lantern products from Bamboo-fibre paper and ginger flower-fibre paper

The students have learnt that a paper is an organic material that is potentially made from cellulose-based plant fibres including bamboo, banana, kenaf, ginger flower, pineapple, lemon grass and corn. As a result, the paper has different rates of brightness, strength, absorbency, stability and rigidity. This suggests that the range of handmade papers made from the selected plant fibres are suitable for making craft products as explored by the students for their studio project. These products can be made in organic and inorganic shapes following the physical properties of the handmade papers. It was found from the colour compatibility test, folding endurance test, and fibre structure identification, the fibres have their distinctive properties which are potential for further exploration to make different craft products. Unlike mechanical paper made today, the traditional handmade paper offers both as a traditional craft and as an art form. Inasmuch, the outcomes from the studio project and based on the analysis demonstrate that raw materials from local plants in Malaysia have wide potentials for papermaking which are suitable for craft product. These materials come from the renewable and sustainable resources, thus ensuring flexibility in the production of handmade papers, especially for contemporary and future craft products.

CONCLUSIONS AND RECOMMENDATIONS

This paper discusses the potentiality of the various plant fibres in the handmade papermaking for craft object as explored by the Applied art and Design students for their studio project. Results from the analyses of the 7 different types of handmade paper samples show some differences in their physical properties. All of the selected plant fibres, namely from bamboo stems, banana trunk, kenaf stems, pineapple leaves, ginger flower stems, corn husks and lemon grass stems are suitable materials to make the handmade papers but with physical distinction. The research found that the papers from fibres of bamboo, kenaf and banana have more refine and smooth texture, strength and rigidity, which are virtuous materials for craft production. The folding endurance test and colour compatibility analysis also reveal that the plant-fibre papers have distinctive characteristics, hence the students can use them to make various forms of craft product. Different fibres yields to different physical characteristics of handmade paper. As a result, each handmade paper has different colour, texture, rates of brightness and opaqueness, strength, absorbency, stability and rigidity. Hence, the handmade papers with different physical characteristics offer many options for craftmaking. In the context of their studio project, the applied arts and design students have many options to choose from for their craftmaking products because various plant-fibres are suitable materials for handmade paper. On top of this, the handmade papers and its papermaking process are low-cost spending because the main materials come from natural resources. In short, the research has distinguished physical properties of the different types of handmade paper and its applicable properties for craft products. As an example, the handmade papers from bamboo, banana and kenaf fibres are suitable to make different forms of lantern due to its textural quality, colour compatibility and strength. The approach of research analysis and its findings as discussed in this paper does not only help the students for their studio project, but also it would benefit the practitioners in the related field. The people in the industries of handmade papers would get benefit from the findings of the research because there is a continuing opportunity for the evolution of paper-based craftmaking. Also, they may further explore using other types of plant fibres available in their environment for the handmade papermaking. As such, the handmade paper makers could take further steps to make their business a truly eco-friendly industry. The traditional hand papermaking generally employs renewable resources, thus ensuring the sustainability of production and economic gain. Paper industry is a multifaceted sector consisting of both informal and formal enterprises with numerous subcategories. Therefore, attention should be given to the positive roles that these enterprises can play in the Malaysian society. The hand papermaking is part and parcel of traditional art and craft sector, which is an integral part of the travel and tourism-linked SME economy of Malaysia. For decades, the support for small and medium enterprises (SMEs) has been a common theme in the central government policy and planning, especially for youth communities' employability and entrepreneurship. Inasmuch, the handmade paper makers could take further steps to make their business a truly eco-friendly industry.

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