EXPLORING THE TROPICAL FRUITS WASTE AS ASH GLAZE FOR ORGANIC CERAMIC SCULPTURE

By

MR. Thatree MUANGKAEW

A Thesis Submitted in Partial Fulfillment of the Requirements

for Doctor of Philosophy DESIGN ARTS (INTERNATIONAL PROGRAM)

Graduate School, Silpakorn University

Academic Year 2021

วิจัยการทำน้ำเคลือบขี้เถ้าจากผลไม้เมืองร้อนสำหรับประติมากรรมเครื่องปั้นดินเผา อินทรีย์รูป

โดย
นายธาตรี เมืองแก้ว

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Field of Study	DESIGN ARTS (INTERNATIONAL PROGRAM)
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MR. THATREE MUANGKAEW : EXPLORING THE TROPICAL FRUITS WASTE AS ASH GLAZE FOR ORGANIC CERAMIC SCULPTURE THESIS ADVISOR : ASSOCIATE PROFESSOR SONE SIMATRANG

The ancient kind of glaze in the history was made by mixing between wood ash and fine textured soil to coat on the ceramic surface. After that, the glaze was fired in the kiln with a temperature over 1,200 ˚c. This research elaborated on the knowledge of changing old glaze, which used wood ash to the agricultural waste. The results of the study have been integrated with making glaze and ideas for creating organic ceramic sculptures in round relief and bas-relief.

Thailand has a tropical climate, so there are several kinds of tropical plants and fruits served as industrial crops sold throughout the country. Since there are extensive consumption, some parts of the fruits became wastes such as rind and fallen fruits. As a result, the researcher was interested in using fruit waste to experiment for making ceramic ash glaze. The results of this study were recorded as new knowledge. People who are interested in ceramics can adapt this knowledge to create the future works.

The researcher analyzed and gathered data and information on ash glaze to conduct an experiment with fruits ash glaze. The study result of tropical fruits ash glaze was integrated with organic ceramic sculpture. The natural forms such as plants and tree leaves were developed to be art forms for an expression of the hidden aesthetic. Furthermore, the beauty and aesthetic that came from natural elements inspired an artwork “Exploring the tropical fruits waste as ash glaze for organic ceramic sculpture”.

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Chapter 1

Introduction

1.1 Background of the Research:

The art of ceramic creation is one of the human cultural prosperity indicators. It has existed in human society for thousands of years. The glaze is the important thing that causes durable and beautiful ceramics throughout thousands of years. It is a chemical compound of alumina and silica called “silicate”. It is liquefied in the thermal process and looks glassy. In other words, the glaze is a silicate that is melted by heat until it is homogeneous and coated on the ceramic products. Ceramic glazing improves the strength and hardness of its surface against strong acid or base well when the firing process at a temperature over 1,200 ˚C (Prompreuk, 1980). These are the properties that have caused ceramic persistence for thousands of years. The ash glaze is one of the ancient glazes. Chinese potters have used the ash glaze since the Han dynasty period (206 B.C.-A.D. 200), or more than 2,000 years ago. (Nakbau, 1993)

After reviewing the literature, the researcher determined that the glaze was made from wood and plant ash. As from the fruit ash, the researcher discovered the information of making the glaze from coffee beans. However, the researcher was unable to locate any recorded data to analyze more information where fruits were use for glazing. Therefore, the researcher would like to examine the manufacturing of fruit ash coating to assess its practicability and record it in a new database for the benefit of those who are interested.

As a result, the researcher is interested in bringing waste from durians and other typical fruits in Thailand to experiment with ash glaze. Since it was used for several types of ceramics, the research findings can be utilized for ceramic creations, and will be the case study of making an own uncomplicated ceramic glaze.

1.2 The Statements of the Problems:

In the past, ash glazes were generated by the usage of burned plants or the wood and blended with fine soil. The glazes were applied or poured on the containers' surfaces before the potteries were fired into the kiln. The raw materials of glazes were melted and became glassy on ceramic surface when it reached the vitreous point. Wood kilns are becoming less common in modern times due to a lack of critical resources like wood. Fuel forests are becoming increasingly scarce. In addition, the energy utilized as a combustion fuel, such as oil, gas, or electricity, is becoming increasingly limited.

The researcher realized the fruit waste problems because of a large consumption and the difficulty of waste disposal. According to the survey, there was a considerable volume of durian rind waste that caused pollution and effected society.

1.3 Objectives:

1.3.1 To explore the potential of tropical fruits waste for ceramic ash glaze.

1.3.2 To experiment tropical fruits waste ash glaze to enhance toward organic ceramic sculpture.

1.3.3 To propose tropical fruit waste as one the ash glazes for organic ceramic sculpture.

1.4 Research questions (RQ):

1.4.1 What is the significant potential of tropical fruits waste that can be enhanced for ceramic ash glaze ?

1.4.2 Why is the tropical fruits waste can be proposed as ash glaze for organic ceramic sculpture ?

1.4.3 What are the significance elements that applicable to be as ceramic ash glaze ?

1.4.4 How is the tropical fruits waste can become one of the materials for ceramic ash glaze for organic ceramic sculpture ?

1.5 Scope of Research:

1.5.1 The following are the research outcomes:

1.5.1.1 Consume leftover fruit waste to experiment for making fruit ash glaze

1.5.1.2 Collect the raw material as tropical fruits waste in Thailand for making ash glaze.

1.5.2 Analyze chemical structure in fruits ash glaze.

1.5.3 Study about ash glaze historical information from various places;

1.5.3.1 Ash glaze general history.

1.5.3.2 Ash glaze in China.

1.5.3.3 Ash glaze in Japan.

1.5.3.4 Ash glaze in Korea.

1.5.3.5 Ash glaze in Thailand.

1.5.4 Ash glaze making and testing process.

1.5.5 Analyze the data of the ash glaze experimental results for using in ceramic organic forms.

1.6 Result of research:

1.6.1 The goal of this study is to convert fruit waste into ash glaze as part of the research process, ash glaze was created as a case study on how to utilize fruit waste to generate the new value.

1.6.2 The knowledge data from recording research results and experiments to be useful to ceramic study.

1.6.3 Organic ceramic sculpture integrates with tropical fruits ash glaze.

1.7 Definitions of Terms:

Fruit, Ash glaze, Ceramic Sculpture, Organic form

1.7.1 Fruit: A plant is ovary that has been fertilized and developed to create some fruit. (Science and Mathematics Textbook Project, The Promotion of Academic Olympiad, and Development of Science Education Foundation under the patronage of Her Royal Highness Princess Galyani Vadhana Krom Luang Naradhiwas Rajanagarindra, 2011: 281)

1.7.2 Ash glaze: it is a thin glass coating created by mixing ashes from wood or plants with different formulas and putting them to the surface of a ceramic item before firing in a kiln. When it reaches a temperature of 1,200 ℃ or more, it will melt through glass that has been plastered on the work surface. The properties are also resistant to acid and alkali. Its purpose is to preserve the ceramics' surface while also providing as a decorative feature. (Nakbau, 1993: 2, Palprame, 2009: 2)

1.7.3 Ceramic Sculpture: is an art that is expressed by the use of clay for materials and the dimensions of form by shaping and firing.

1.7.4 Organic form: Organic forms look natural. They are irregular and may seem flowing and unpredictable. The most obvious example of organic forms are realistic representations of the natural world or living things. (BBC, 2021)

1.8 The overview of the thesis.

The overall thesis is comprised of 6 Chapters. Chapter 1 is focused on the introduction and backgrounds this research. This includes the introduction and backgrounds of the research, the statements of the problems, objectives, keywords, limitations and delimitations and the significance of the research. Chapter 2 is focused on the Literature on the fundamentals of tropical fruits waste as ash glaze for organic ceramic sculpture. Chapter 3 is focused on the Research Methodology

that is employed in the process of collecting data or information. The overall research data collection is employed by using Qualitative or Quantitative research approaches in the two phases of data collection processes. Chapter 4 is emphasized on the discussions of findings of first phase data collection processes. Meanwhile chapter 5 is emphasized on the 2nd phase data analysis, and finally chapter 6 is focuses on the conclusion and recommendation of the research and to fulfil the research objectives.

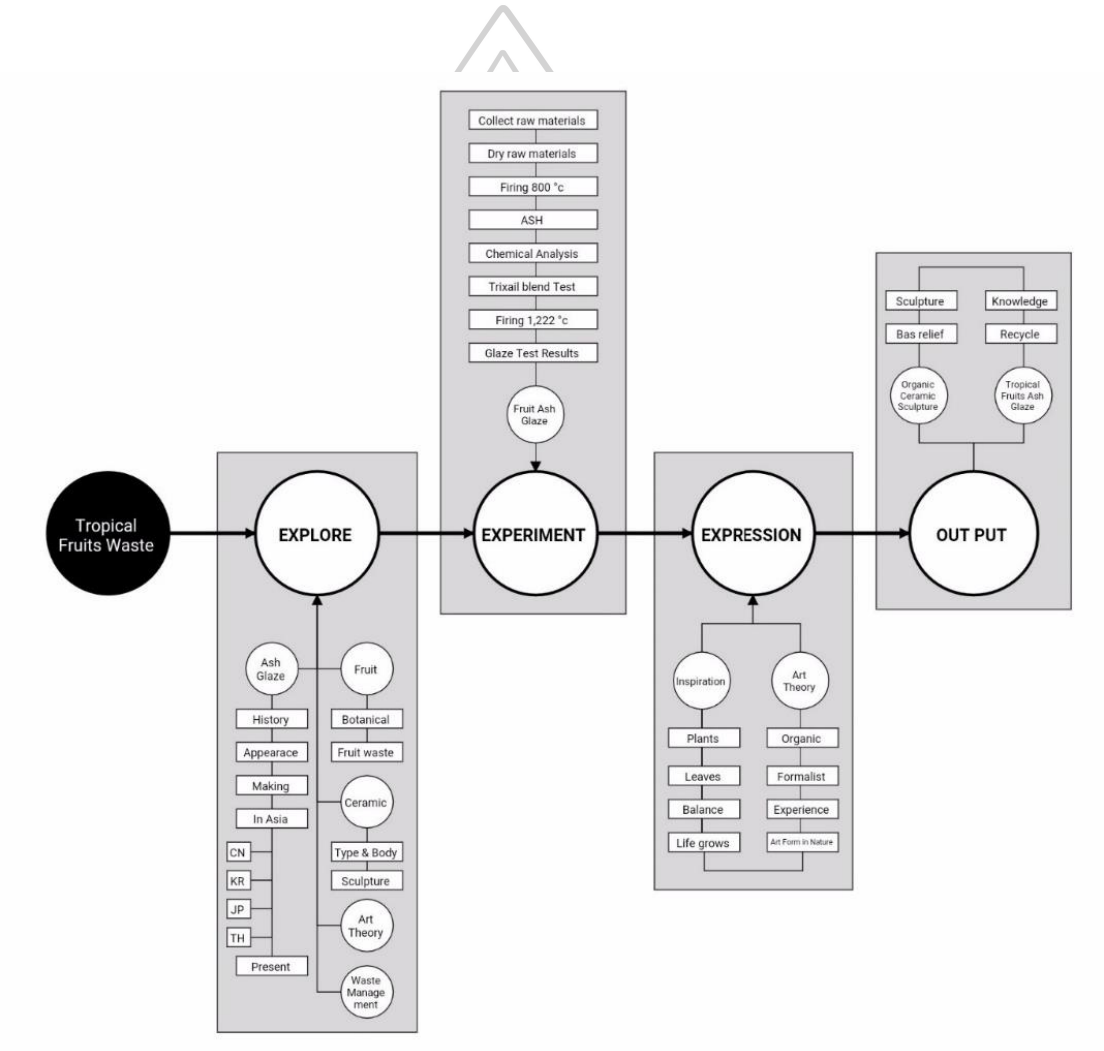


Figure 1 Research Process Flowchart

Chapter 2

Theories and Literature Review

The aim of this research is to study the process of making fruit ash glaze for ceramic creations. Due to Thailand is a major of agricultural country, which is rich in biodiversity. There are many tropical plants and edible fruits but some parts of them are useless, especially the shell. It was discarded as a considerable amount of waste. Therefore, the researcher is interested in employing the ceramic manufacturing process to convert those fruit leftovers to be ash glaze for ceramic works. The work begin with a study of using fruit waste, which is prevalent in modern times for making fruit ash glaze. In addition, the study approach for producing ash glaze was produced by the sorting of fruit waste. The researcher, on the other hand, has examined the history of ash glaze in various places such as China, Japan, Korea, and Thailand, as well as ash glaze in current times. Furthermore, the glazing method employed in the firing of the test plates. In conclusion, this was an art study technique for glazing on organic ceramic form as sculpture and bas relief. It is related the following in three parts:

Part 1 Ash glaze

Part 2 Fruit

Part 3 Art theories influence on Ceramic Sculpture

Research Theories and Literature Review Process Diagram.

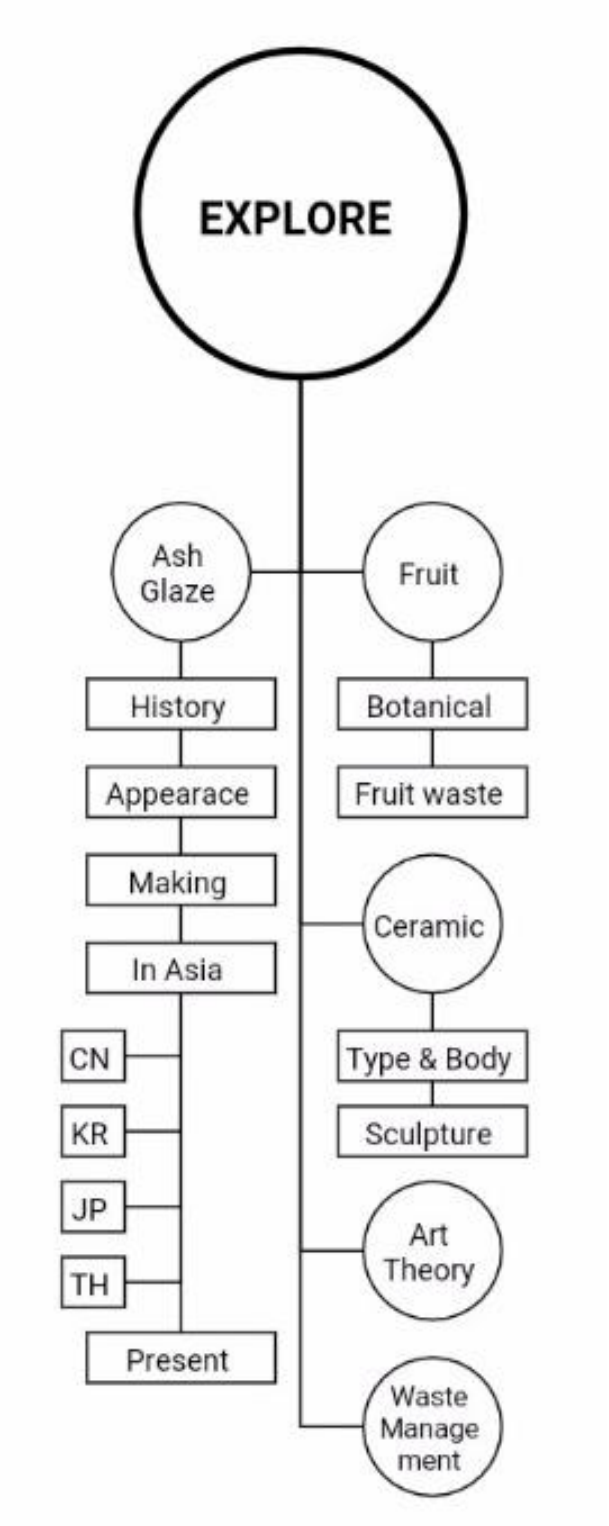


Figure 2 Research Theories and Literature Review Process Flowchart.

Part 1: Ash glaze.

2.1 Ash glaze history

Ash ceramic glazing is caused by various types of wood coating, which is an accidental discovery and is common in East Asia. Ash glazing has a long history around 1500 BC since Shang Dynasty in China. Wood kilns are used to burn pottery with the ash from the fuel flickering to the surface of the pottery and the annealing of the ashes on the surface. There is a glossy glaze plastered on Pottery's skin. It seems that ceramic works were coated with thin glass. After it was melted, it transforms into a glaze. The craftsmen learned to mix the ash and fine-textured soils for applying on the pottery surfaces before loaded into the kiln. This is the origin of ash glazes. There is a substance in plant ash which is called “calcium oxide”. It can be used in ceramic glazing. (Nakbau, 1993; Palprame, 2009)

Figure 3 Printing picture Heavenly Creation and Ceramics.

Source: Jingdezhen China Ceramics Museum. Photo by Researcher, 2019.

2.2 Ash glaze appearance

The color of the coating is affected by the appearance of glazed ashes. Most of their colors vary from dark brown to ash glaze green. There are earth tone colors. Glazing color is determined by the amount of ash added to the coating as well as the features of the plant that applied for the coating. Even the same trees grown in different soils provide different results. Because of plant mineral deposits in different areas of the tree or plants and harvesting changes by season to get varied outcomes. The thinness or thickness of the coating also contributes to various coatings. (Nakbau, 1993; Palprame, 2009)

Figure **4** Various type of Sangkahalok product. Sukhothai art (15th -16th century).
Source: Kamphaeng Phet National Museum. Photo by Researcher, 2018

2.3 Making the ash

The ash must be burnt in the coating process. The value of burning wood for ashes is roughly 1% of the original mass. Then, using an 80- to 120-mesh, and sift the ashes to eliminate to any undesirable components, such as charcoal or other substances. To avoid chemical risks, some potters soak the clay for a longer period before applying the ashes. Some alkalinity contained in soluble ashes in the use of different plants also yielded different coating effects.

Figure 5 Lady crushing ash at ceramic factory in Ratchaburi province, Thailand.
Source: Varieties mood and style of ash glaze (Pages 12) by Sermsak Nakbau, 2004.
Bangkok: Amarin printing and publishing.

2.4 Ash in science

Examining scientific ash compounds such as calcium carbonate, potassium carbonate, phosphates, and so on. Many types of glaze have different percentages of compounds. It depends on the soil where those crops are grown, and there are other factors. Clearing, grinding, and combining glaze are factors for result in various outcomes. (Palpreme, 2009)

2.5 Ash glaze in

Currently, ashes are used for less than half of the Ash glaze dosage. Other components are typically added to aid in smelting, such as Feldspar and colored glaze for Oxide, which are becoming increasingly scarce. There are some potters use ash glaze with traditional coatings such as Korean potters , they use ashes mixed with water for coating bowls, cups and tea pots. In Thailand, there is the glazed water jar with dragon patterns factory in Rachaburi province. This technique is still used to cover dragon jars, pots, and other ceramic utensils with Ferric oxide mixed for making colors.

Figure 6 Process of Celadon.

Source: Siam Celadon ceramic factory at Sankamphaeng District, Chiang Mai, Thailand. Photo by Researcher, 2018.

2.6 Case study ash glaze in Asia

2.6.1 Ash glaze pottery in China

Between 1600 and 1100 BC, the Shang dynasty in China created stoneware pottery with ash glaze. As a result of the development of kilns capable of converting fuel to ashes. At temperatures above 1,200 ℃, molten ash collects on the surface of the pottery. It appears like a thin coating of glass has been plastered on the surface of the stoneware pottery/Learning how to apply ashes to the surface of the stoneware pottery before it is burned in the kiln. It was a success before Japan, Korea, and Europe found a way for making ceramic glazes (Foxy Wolff, 2015).

There were many different types of wood ash glazes were employed in the early days, as well as innovative kilns that were burned at high temperatures. The Shang dynasty's Chinese pottery was a precursor for the creation of Chinese stoneware with thin glaze layer. This glaze was passed down from the Han period and is being used today. (Foxy Wolff, 2015)

Figure 7 Dragon Kiln Painting.

(Online) accessed April 20, 2020, available from

https://web.facebook.com/dragonkiln.pot/photos/a.112170770325514/151141129761811

Stoneware was not glazed in the early days. Coating on the surface of pottery occurred because of calcium and feldspar in the soil being burnt at high temperatures, as well as ashes in the oven being melted on the surface of the pottery. These components are derived from crushed shellfish as well. Silica, Alumina, and Calcium Carbonate make up its chemical makeup. The glaze varies in color from yellow to green based on the titanium and iron concentration in the clay mixture. Eventually, the ash in the glaze is frequently replaced with limestone, as seen in Yue pottery created under the Five Dynasties in the early 10th century. (Foxy Wolff, 2015)

Figure 8 Chinese, Shang Dynasty Pottery.
(1,600 – 1,100 BC). (Online) accessed April 20, 2020, available from *www.foxywolff.files.wordpress.com/2015/03/shang-1.jpg*

From inquiries to ceramic teachers in China, information on how to make Chinese ash glaze is as follows:

There are many kilns opening in China and the area is very wide. The glaze is different from the north to south, from East to west because of the fuel (Trees) use for firing are different in each region but pine trees are often to used (Fei, 2021)

Regarding the glaze made from ash, Jingdezhen generally uses wolfwood (Chinese name: Langqi wood) and quicklime stone to calcine the best. As for other grass and wood, of course, it is also possible. The discovery of ceramic glaze in my country was in the Han Dynasty They used local materials in cave kilns or ground. The nearby vegetation is burned to form an embryonic glaze. (Zhiwen, 2021)

Figure 9 Chinese, Shang Dynasty Pottery
(1,600 – 1,100 BC). (Online) accessed April 20, 2020, available from
www.foxywolff.files.wordpress.com/2015/03/shang-1.jpg

However, at the very beginning, in ancient China, there was no indication of what kind of wood was used to make ash, and it was made from nearby materials. In the early development of ceramics, the original celadon in the Shang Dynasty, until the Eastern Han Dynasty, should be made locally. As far as I know, the appearance of the celadon pots near Xi'an and the celadon pots from Zhejiang province are quite different. It is also said that the imperial kiln in the Yongzheng period used thorn grass ash, and some parts of the south used bamboo ash. During the Ming and Qing Dynasties, there was no fixed standard. The soil contains different elements in different plant growth environments, and there are different alkali metals in the ash. And hydrochloric acid, so it has different performance on ancient Chinese North and South porcelain. (Zhiwen, 2021)

Figure 10 Chinese, Shang Dynasty Pottery.
(1,600 – 1,100 BC). (Online) accessed April 20, 2020, available from
www.foxywolff.files.wordpress.com/2015/03/shang-1.jpg

2.6.2 Ash glaze pottery in Japan

Until the firing technique developed, Japanese daily pottery, such as bowls and other utensils, was not glazed. The Japanese learned about glazing ash, dark brown. This is a glaze discovered by ancient Chinese craftsmen using firewood as a fuel for burning. It comes directly from China. When heat flows into the kiln during the pottery firing, the ashes from the firewood are pulled into the kiln and melt into glaze when heated to the melting point. Melts will dissolve more easily if normal wood contains alkali, potassium, and sodium.

Figure **11** Freer Gallery of Art,

,Smithsonian, Tamba Ware Storage Jar, Muromachi Period, Circa 1400-1450

(Online) accessed April 20, 2020, available from

https://japanobjects.com/features/japanese-pottery

In the ancient times, artisans would employ drainage methods or sprinkle ashes directly on the container's shoulder. It will be coated in some areas before entering the kiln and flows in one way or another It is determined by the ash content's strength and a sufficiently high firing temperature. Wood ash is made by burning sawdust, corn stalks, or other trees partticles and immersing them in a large amount of water, then draining the water.to remove as much alkalinity from the ash as feasible Dry ash combined with feldspar, as well as ground dirt combined with ash The ash glaze described will melt at a high temperature of around 1285 degrees Fahrenheit, providing control of the glaze flow.

Figure **12** Echizen ware sake bottle (tokkuri)
,Momoyama period, late 16th century
(Online) accessed April 20, 2020, available from
https://japanobjects.com/features/japanese-pottery

Nuka Glaze began many years ago in Japan. Traditionally, it was produced from ashes from burned rice husks. Due to these ashes are rich in silica, the former of glass, certain Nuka glazes are produced with ash. Phil Rogers describes Nuka glaze in his book "Ash Glazes".

Figure 13 Echizen ware widemouthed oil jar(kame)
with wave pattern,stoneware with natural ash glaze, Edo period, 18th century
(Online) accessed April 20, 2020, available from *https://en.wikipedia.org/wiki/Echizen_ware#/media/File:越前櫛描波状文甕Widemouthed_Oil_Jar_(Kame)_with_Wave_Pattern_MET_2015_300_265_Burke_website.jpg*

Shoji Hamada, a Japanese potter, created the Nuka glaze sample. Handcrafted ceramics inspired by his natural environment and constructed of natural materials. Nuka glaze, created with ashes and stones, 50/50, naturally collected locally (Cherrico, 2012).

2.6.3 Ash glaze pottery in Korea

Ash glaze pottery in Korea has been continually developed and influenced by Chinese ceramics and Buddhism. As there is a jar for collecting ashes that is adorned with lotus and cloud motifs. Most of the antique pottery is unpainted/some pottery has a distinctive decoration. High fire pottery was primarily imported from China during the Silla period (AD 668-935)/ Ash glaze pottery in Korea was developed into Celadon during the Goryeo period/ subsequently evolved to distinctive and exquisite celadon ceramics with inlay and carving methods (Jung & Choi, 2004; Cartwright, 2016; The Museum of Oriental Ceramics, Osaka, 2020)

Figure 14 Bowl, Stoneware with wood-ash glaze Goryeo period
or Joseon period, late 14th-early 15th century, Collection Freer Gallery of Art, Object number F1897.86 (Online) accessed April 22, 2020, available from *https://ids.si.edu/ids/deliveryService/full/id/FS-7769_11*

Celadon and white pottery initially appeared in Korea during the Goryeo dynasty (918-1392)/ Goryeo celadon was inspired by Chinese Yue ceramics during the Five Dynasties (907-906)/ later in the twelfth century. Goryeo celadon pottery was invented in Korea, and it employs a blue glaze called Bisaek (Kingfisher Color), which is extensively adorned with inlay methods. Goryeo celadon was made at Kangjin and Buan, both in the southwest of the Korean Peninsula. (Jung & Choi, 2004; Cartwright, 2016; The Museum of Oriental Ceramics, Osaka, 2020)

Figure 15 Tea bowl in style of Goryeo celadon
,Stoneware with white and black inlays under celadon glaze, Joseon period, second half of 17th century (Online) accessed April 22, 2020, available from *https://ids.si.edu/ids/deliveryService/full/id/FS-7917_23*

Figure **16** Bottle, Stoneware with black and white slips under celadon glaze ,Goryeo period, 12th century, Collection Freer Gallery of Art, Object number F1909.31 (Online) accessed April 22, 2020, available from *https://ids.si.edu/ids/deliveryService/full/id/FS-6236_03*

2.6.4 Ash glaze pottery in Thailand

2.6.4.1 Buriram pottery

Buriram pottery, commonly known as Khmer pottery or Lopburi pottery, is made in Thailand. This style of pottery was discovered in Buriram Province and was influenced by Khmer art. It is thick and substantial scraping into various patterns and sculpting into the shape of animals such as birds, chickens, elephants, and so on. There are common ways to adorn it. Brown is a popular coating. Coating kind that produces brown and black hues which is categorized as a "Qian" glazing by the Chinese. It is a thick dark glaze. The glaze was developed later in the Song Dynasty era to include oil stains.it appears to be silver, gray rabbit hair. This is caused by liquid coating with iron oxide burning by introducing oxygen. China's influence is seen in the dark glaze. Teacups are used in China.

The Japanese utilize a lot of brown porcelain to produce dark brown porcelain known as "Temoku." This pottery in dark brown is highly recognized across the world. Khmer's dark brown glaze, on the other hand. There will be no oil leaking, but it is just a regular brown covering. However, it is a glaze made from rich clay, limestone, and iron. This is a widely available raw ingredient that aids in the melting process at 1200 degrees Celsius. Although not as sophisticated, Khmer ceramics. However, the green of celadon is comparable to that of China. It is a prototype of the Celadon glazing machine in Southeast Asia and the Far East, where ceramicists develop both surfaces. The chemical clay of sintering glaze and shape is famous for its beautiful products. (Predichayapan, 2009)

Figure 17 Covered box of ‘thistle-type’ shape.
Grey body with black specks is covered in a brown glaze which pools in the incised areas of carved vertical lines. From Northeast Thailand, Late 11th Century

(Photo source: Stock 1981: fig. 63) “eMuseum Southeast Asia Ceramics” (Online) accessed April 28, 2020, available from *http://www.museum.seaceramic.org.sg/cambodia/buriram-and-surin-province/*

Buriram Kilns were primarily utilized in the 11th and early 12th centuries, until the construction of Angkor Wat. During the Khmer civilization period, the birthplace is in northeastern Thailand, today known as the Korat Plateau. The motivation for the creation of significant structures such as Phimai Castle and Khmer-style pottery.

2.6.4.2 Sukhothai pottery

Sukhothai pottery, called as "Shangkalok," was well known. This pottery from a kiln at Wat Si Chum is painted with the Suzhou method, which originated in China. It is a robust pottery that frequently produces huge vessels with white clay methods and a black-brown donkey on a white background. After painting with clay, many were damaged and scraped into the earth. After burning at 1230 °c, there are white and then etched brown grooves in transparent glaze. After calcination, brown is evident on the white surface beneath the glaze. (Predichayapan, 2009)

Figure **18** Plate, Sukhothai art (15th -16th century).

Source: Ramkhamhaeng National Museum. Photo by Researcher, 2018.

Sukhothai pottery is distinguished from Chinese Suzhou pottery by the shape of the pottery and the design, as well as the color inscribed on it, white. China is also teaching us. The figure, on the other hand, is the most common motif as striped fish with flower and conch motifs. The pottery produced by the Sawankhalok Kiln which is comparable to that produced by China's Lung Chuan Kilns and Yao Chao kilns during the Song Dynasty. Celadon or light green, and techniques produced by sharp tools or scraping deeply on the surface of the vessel by having a green inlay on the design. Enhance the pattern's clarity and beauty. The kiln used to burn Sukhothai porcelain is known as texture, and it has an oval form with a three-part hood. Pottery from the Sawankhalok Kiln is similar to those produced by China's Lung Chuan Kilns and Yao Chao kilns during the Song Dynasty. There is a celadon or green glaze feature that is comparable to the technique of making use of sharp items or Scratch deeply on the surface of the container with green lacquer integrated in the design. Enhance the pattern's clarity and beauty. (Preechayaphan, 2009)

Figure 19 Plates painted fish pattern, Sukhothai art (15th -16th century).
Source: Sankhalok Museum. Photo by Researcher, 2018.

Europeans popularly called the word "Celadon" a green-grey-blue glaze, but in Chiang Mai pottery advertisements "Celadon" comes from the words "Sila and Dal". The Sanskrit term refers to the glaze on the rock, which is generally celadon or Sangkhalok (Predichayapan (2009). Sukhothai is a porcelain from Siam, which shown

the first attempt to be able to glaze over high fire. Sukhothai's strong glaze pottery made from plant ashes and clay mixes. Chemical analyses have revealed that certain plants and plants include a percentage of Silica, Alumina, Alkaline (Sodium, Potassium), and Calcium chemicals for good measure. (Predichayapan, 2009)

Figure **20** Plates, Sukhothai art
(15th -16th century) From Sankhalok Museum.

Photo by Researcher. 2018.

In creating green or celadon color, reduction firing is used to induce the glaze to shift from where it should be, softening and deepening the color that should have been absorbed, such as green. The stated green Sukhothai Sangkhalok glaze is created from Ferric oxide Oxide in the glaze, which, when burnt with oxidation fire, produces a hue ranging from oak yellow to dark brown. However, lowering the firing temperature makes the hue to shift from brown to grayish green or green, which potters have learned over time.

Part 2: Fruit

2.7 Fruit meaning

It is a fertilized ovary that grows into fruit. Some parts of the flower such as the peduncle, sepals, and seeds may also grow. An unfertilized ovary or seedless fruit is called parthenocarpic fruit. (Sripleng et al., 2007)

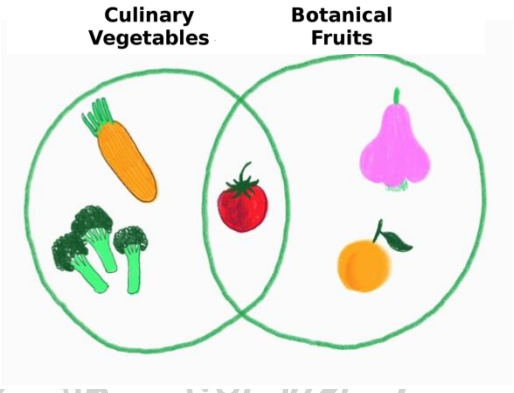


Figure 21 Venn diagram

representing the relationship between (culinary) vegetables and botanical fruits.

Drawing by Researcher, 2018.

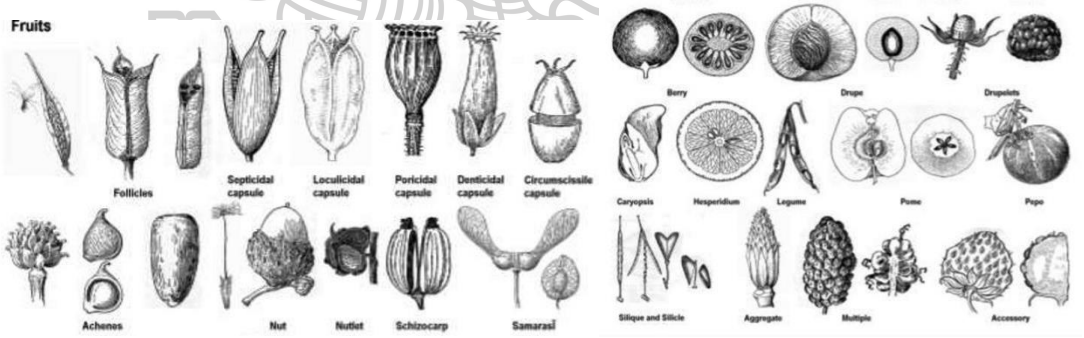


Figure 22 Botanical Classification of Fruits

(Online) accessed April 30, 2020, available from

https://vegetablesandfruitsimagehd.blogspot.com/2019/09/botanical-classification-of-fruits-ppt.html

2.8 Structure of Fruit

The structure of the fruit is mainly composed of the pericarp and the seed. The pericarp is the part that develops from the ovary. The fruit wall, or pericarp, is divided into three regions: the inner layer, or endocarp; the middle layer, or mesocarp; and the outer layer, or exocarp.

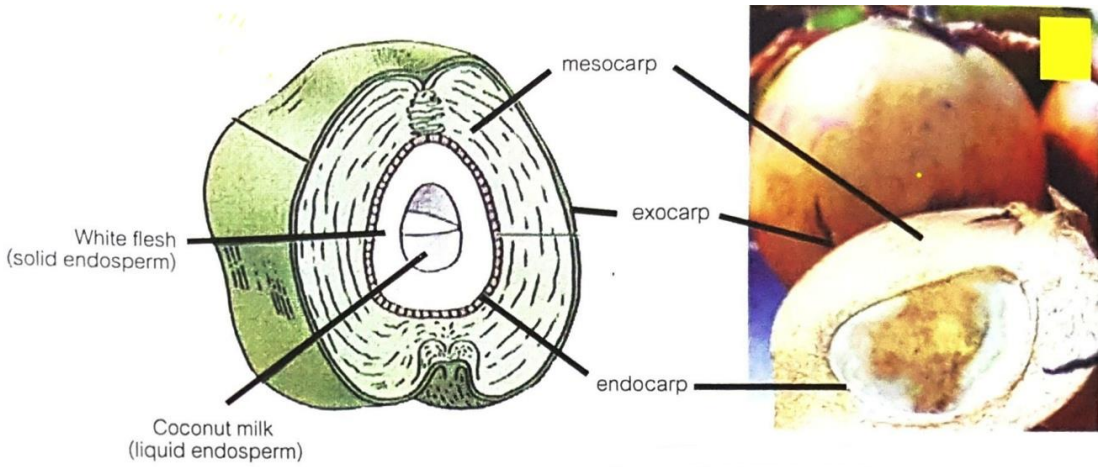


Figure 23 Section show structure of Coconut.

Source: Picture from Science and Mathematics Textbook Project สอวน. Foundation "Biology 1". Page 284.

- The inner layer (endocarp) has both soft texture like orange and hard texture such as mango, and coconut.
- The middle layer (mesocarp) is commonly soft such as mango, and papaya.
- The middle layers of some fruits have sticky fibers such as coconut, palm, and nipa palm.
- The outer layers (exocarp) of some fruits have thin or soft skins such as grapes, rose apples, and mangoes. Some fruits have hard and sticky outer skins such as coconuts and pumpkins.
- Seed is a fertilized and mature ovule consisting of two layers of seedcase; the outer layer and the inner layer, the endosperm and the embryo.

Figure 24 Dried Tropical fruits as Researcher found in Thailand.

Photo by Researcher, 2018.

2.9 Classification of Fruits

Simple Fruit: A type of fruit that comes from a single flower. The pistil contains one or more connected carpels such as water melon, papaya, orange, and mango.

Aggregate Fruit: A type of fruit that arises from a single flower but it has many carpels. Each carpel is separated and will grow into sub-fruits such as custard apple, climbing ilang-ilang, white champaca, magnolia champaca, and strawberry.

Multiple Fruit: A type of fruit that is produced by many florets. Flowers which are in the same inflorescence grow as a single fruit such as jackfruit, pineapple, and morinda citrifolia.

Syconium: It is a hollow multiple fruit which grows from hypanthium. There are small dioecious sub-flowers without petals in the fruit. The inner part of inflorescence has an ostiolum allowing small insects to pollinate such as banyan, fig, and East Indian fig.

2.10 Types of Fruit

2.10.1 Fleshy Fruit

It is the mature fruit that has a fresh pericarp and it is not dry. It is divided into drupe, berry, pome, pepo, and hesperidium.

Drupe: A one-seeded simple fruit developed from a superior ovary in which the innermost portion of the wall (endocarp) becomes hard and stony, the outermost part (exocarp) becomes a relatively thin skin, and the middle portion between the skin and the stone (mesocarp) becomes either fleshy or fibrous. Some of the examples of drupe fruits are peach, plum, nectarine, apricot, cherry, olive, mango and almond.

Berry: The ovary wall of the carpel becomes almost completely fleshy at maturity. The number of carpels in each species varies from one to several and their skins can be thin and tender or thin and tough. The number of seeds also varies from one per carpel to many per carpel. The seeds of all berries, are embedded in the fleshy tissue of the carpel (e.g., grape, tomato, papaya, pomegranate, sapote, persimmon, guava, banana and avocado.

Pome: Apple is the most common pome variety. The pome variety has a thick skin and fleshy tissue within. The fleshy tissue is the edible part of the fruit. In the inside of the apple, there is a thin paper-like layer which covers the seeds. The ovary starts from this layer. In some apples, the dry flower base can be visible. Some of the other examples of the pome variety are pears and quinces.

Pepo: The pepo is covered by a rind that is hard and thick. The cucumber, pumpkin and watermelon are good examples of the pepo type of fruit. Below the rind, the rest of the ovary wall is soft and fleshy. In the photographs above seeds fill the locule of each carpel.

Hesperidium: Hesperidium type fruits are always covered with a leathery rind and the partitions separating their carpels are tough and fibrous. The orange, lemon and grapefruit.

2.10.2 Dry Fruit

Dry fruits are naturally dried fruits which do not contain a fleshy part. Dry fruits are classified as either dehiscent or indehiscent.

Dehiscent Fruits: Dry fruits which are at maturity and opened by definite natural means to shed the contained seeds.

Legume: A dry dehiscent fruit developed from 1 carpel and at maturity splitting along both the dorsal and ventral sutures - e.g., beans, peas.

Follicle: A dry dehiscent fruit developed from 1 carpel and at maturity splitting along only one suture- e.g., larkspur, columbine.

Capsule: A dry dehiscent fruit developed from several carpels.

(a) **Loculicidal capsule** - one which splits along the outer median line - e.g., lilies.

(b) **Septicidal capsule** - one which splits along the septa and opens at the top- e.g., yucca, agave.

(c) **Silique** - a special long slender capsule of 2 carpels- e.g., mustards.

(d) **Silicle** - a special short broad capsule of 2 carpels- e.g., mustards.

(e) **Pyxis** - a capsule which has circumscissile dehiscence- e.g., plantain, amaranths, purslane.

(f) **Poricidal capsule** - one which opens with round holes- e.g., poppies.

Indehiscent fruits: Dry fruits which do not open when mature to shed their seeds. Many of this group are one seeded fruits.

Achene: A one-seeded, dry, indehiscent fruit; the one seed is attached to the fruit wall at a single point- e.g., buttercups, dandelion, sunflower.

Nut: A dry, indehiscent, one seeded fruit similar to an achene but with the wall greatly thickened and hardened - e.g., beech, chestnut, oak, hazel; walnut and hickory.

Samara: A one- or two-seeded dry, indehiscent fruit in which part of the fruit wall grows out into a wing- e.g., elm, maple, ash.

Grain: A one-seeded dry, indehiscent fruit in which the fruit wall and the seed coat are fused- e.g., wheat, corn, grasses.

Schizocarp: A fruit formed from several carpels, each carpel of this pistil enclosing a single ovule, at maturity the carpels separate as separate indehiscent fruits- e.g., mallow, wild carrot, dill.

Part 3: Fruit wastes

2.11 Fruit wastes

Thailand is a country in Southeast Asia that is rich in a wide variety of plants and fruits. There are many economic fruits that generate income for the country such as durian, mangosteen, litchi and longan, etc. As the researcher saw the leftover fruit waste from the consumption and the mature fruit falling under the trunk, those fruits were grouped to study as follows.

The leftover fruit waste from the consumption is a large amount of waste causing problems in waste management. As a result, the researcher studied about making fruit ash glaze by using following fruits.

Figure 25 - 26 News about Durian waste

(Online) accessed on May 26, 2019. Available from

https://www.posttoday.com/social/local/498074

and https://today.line.me/th/v2/article/DymRxX

Figure 27 Researcher survey waste waste from Nipa plam rind
at Don Hoi Lot, Samut Songkhram Province, Thailand. Photo by Researcher, 2018.

Figure 28 Researcher survey waste from Coconut rind
at Damnuen saduak District, Ratchaburi Province, Thailand.
Photo by Phusit Rattanapanop, 2019.

2.12 Waste Management

The European Union categorizes waste management processes into five categories, which are as follows:

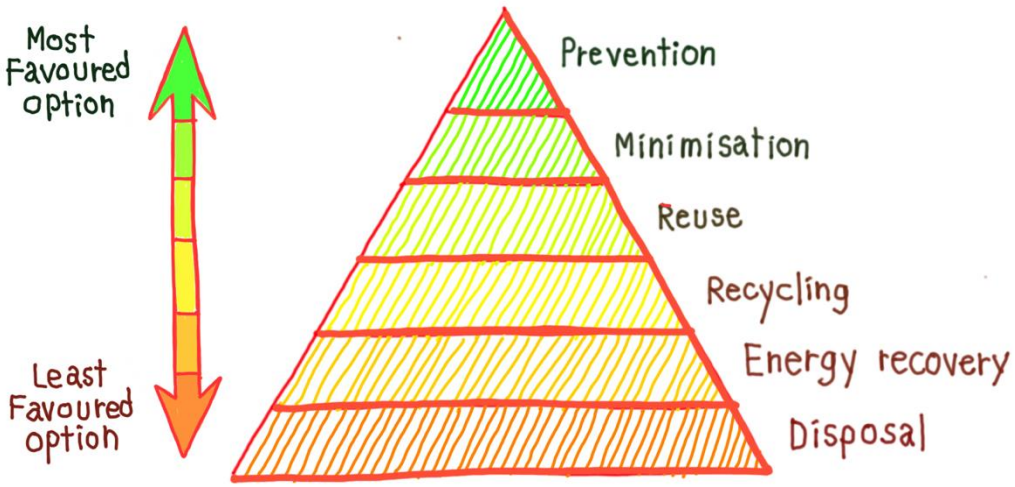


Figure 29 The waste hierarchy.
Drawing by Researcher, 2019.

2.12.1 Waste prevention

Is the EU's top priority among all trash management procedures because it may minimize the quantity of waste and chemicals utilized in various goods used in the process.

Waste management will be less difficult which guidelines of waste prevention can be achieved through improvements in the manufacturing sector, such as designing reduced products. Use of packaging, etc.

2.12.2 Reuse

If waste cannot be avoided, the next step is to use the appropriate materials.

Leftovers to be repurposed. Reuse guidelines include directing manufacturers to create items that may be used or reused. Some elements of the product are reusable, or the seller controls the usage of packaging when returning the goods.

2.12.3 Recycle

The next step of waste management is recycling. If we cannot bring the materials to use, the leftover cannot be reused directly, it must be transformed to be used in other ways as much as possible, such as going through the production process to be raw materials or new products, which will be seen as recycling. A process that uses energy and resources to manage.

2.12.4 Resource recovery or reclamation

At this level, waste management entails the separation and gathering of reusable resources from waste materials such as minerals, energy, or water by a process or extraction from which objects recovered may not be used for their intended use.

The recovery of resources from waste is classified into two broad categories:

2.12.4.1 Valuable material recovery: This is mineral extraction. It contains valuable components such as precious metal extraction from metal-containing trash.

2.12.4.2 Energy recovery: This is the process of converting trash into energy (Waste-To-Energy).

Waste can be recycled and converted into energy, heat, electrical energy, or fuel by a variety of processes such as incineration (combustion), gasification, and high-temperature chemical breakdown of organic materials in pyrolysis, anaerobic digestion, and landfill gas extraction.

2.12.5 Waste disposal

Waste that cannot be reused or recycled will be incinerated. Waste will be burned or landfilled as the final step in waste management, although it may be processed first.

Physical treatment is the process of separating the constituents of trash or making the material more concentrated. Without causing changes in the chemical structure of the material, such as filtering and sedimentation,

Chemical treatment: a procedure that results in chemical processes such as oxidation and reduction reactions, among others. To alter the shape of any element in one or more components to remove them from trash or make them less hazardous. Both physical and chemical wastewater treatment plants are frequently employed to handle organic and inorganic waste.

Waste that has been sorted may need to be disposed of, and wastewater left over following treatment might be released or evaporated.

Biological treatment: This is the treatment of liquid organic wastes. Most of them are waste conditioning through chemical treatment. To begin with the waste contains inorganic substances. The treatment will be in sludge or effluent discharge.

Activated sludge is a wastewater treatment method that uses bacteria as the main decomposition of organic matter in wastewater.

Sequencing Batch Reactor is a wastewater treatment in activated sludge system, add-in and discharge type. Fill and draw activated sludge with steps to wastewater treatment that differs from other activated sludge systems. It is aeration and sedimentation that carried out sequentially within the same reactor.

The trickling filter method is a system that allows microorganisms to grow on the treated wastewater's middle surface and then allows it to pass through the

microbial layer that settles in the intermediate layer by using oxygen reacts to breakdown organic materials in wastewater.

Water flowing through the system is sent to the final sludge tank, where the clones are separated until the effluent can be discharged.

Waste incineration Waste is burned at extremely high temperatures (600 to 1700 °C). It is determined by the technology employed to convert ashes, combustion gases, and heat. It reduces waste mass by 80 to 85 percent and trash volume by 90 to 95 percent, but it does not remove heavy metals that have been combined with garbage.

Landfill trash will be disposed of on-site in order to remove soil. It is intended to permanently retain trash and avoid leakage that is hazardous to the environment.

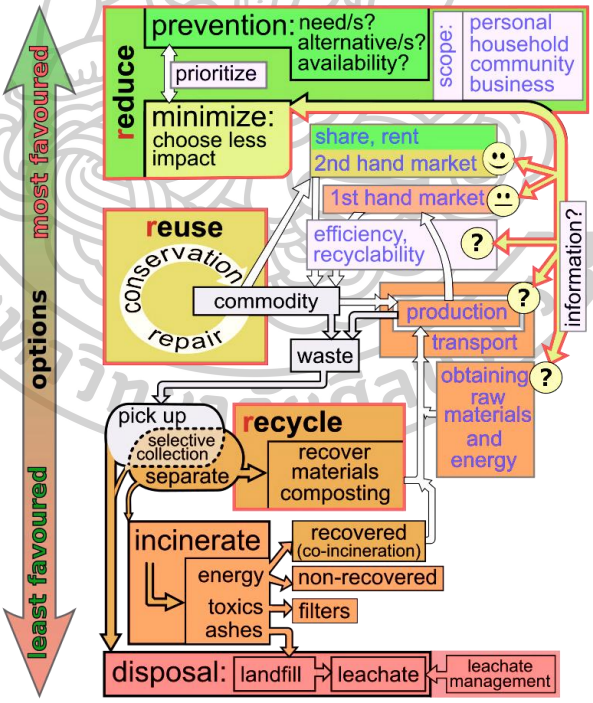


Figure 30 Enhanced version of waste hierarchy.

(Online) accessed on May 26, 2019. Available from *https://en.wikipedia.org/wiki/Waste_hierarchy#/media/File:Waste_hierarchy_rect-en.svg*

Part 4: Ceramic Sculpture

2.13 Ceramic Sculpture

Ceramic Sculpture is an art that is expressed by the use of clay for materials and the dimensions of form by shaping and firing.

Sculpture is an art that is expressed by the use of materials and the dimensions of form. (Nimsamer, 2001)

The word “ceramic” is derived from Greek language “keramos”. It means some materials that made by shaping and firing. In the past, traditional ceramic made from clay was mostly used. Initially, it was also called “chinaware” to honor the Chinese potters who pioneered the production of potteries. (Prompreak, 1980)

Figure 31 Terra-cotta figure with a headdress of flowersc. 3000 B.C.
(Online) accessed on May 28, 2020. Available from
http://www.people.vcu.edu/~djbromle/artviewsnet/portrait04/jithin/indusvalley.htm

Figure 32 A group of terracotta figurines from Harappa.
(Online) accessed on May 28, 2020. Available from
https://www.harappa.com/figurines/1.html

2.14 Ceramic types and clay body.

There are generally many types of pottery products but they can be categorized into 3 major types according to the soil textures and the firing temperatures. These types are as follows:

2.14.1 Earthenware.

2.14.2 Stoneware.

2.14.3 Porcelain.

2.14.1 Earthenware.

It is the most popular type of ceramic products commonly made by using low firing temperature (1,050 - 1,100 ℃) at cone no. 01 to 04. The general appearances of earthenware are relatively thick, coarse-textured, and has tons of porosity. The colors of most products are light brown, light grey, or light yellow. They are glazed or unglazed potteries. There is a dull sound when it is knocked in contrast to other types that there is an echo.

Figure 33 Ceramic, earthenware clay body.

Made by Researcher, 2019.

Most of clay bodies are prepared from the common clay which can be found in the local area. Ball clay is usually dark brown or dark gray. When this clay is mixed with the grog, it would be more porous and can prevent the ceramic products from breaking.

Figure 34 Ceramic, earthenware clay body.
Made by Researcher, 2018.

Red clay or surface clay is ubiquitous and very fine-grained. Although it is slowly dry, it is cohesive clay. When it is fired, it will turn light brown. It is suitable for making various shapes such as free form, spiral form, and flat form by wheel throwing, press molding, and extrusion processes, etc. Mostly, this type of clay has a high percentage of iron. It is not commonly used as the composition of white coloration on products.

Earthenware clay bodies, which used for producing big size products, were mixed with sand or grog to form the clay into a variety of ceramic products

effectively. When the clays are fired, they will have high-strength textures. Besides, the firing process can control the clay shrinkage and prevent the products from breaking and distortion.

Currently, the idea of making white ware products by mixing quartz or flint is popular due to the strength of product textures. Feldspar is an important composition in ceramic and glaze. It can reduce the temperature of vitreous point if it is mixed in the proper ratio. It is necessary to be sticky for forming.

Figure 35 Ceramic, earthenware clay body.
Made by Researcher, 2009.

White earthenware products are prepared from raw material, kaolin clay. It has important properties such as dense texture, opaque, and appropriate porosity. There are various ceramic products coated with different colors of white opaque glazes; for example, dishes, bowls, containers, utensils, and decorations. Clay pots, flowerpots, ewers, bricks, terracotta, etc. are the other earthenware products made from common red clay.

2.14.2 Stoneware

Stoneware products refer to products that are fired at relatively high temperatures (1,190 -1,390°C) from cone 06 - 14 until it reaches the maturity point (Vitreous ware). Most of clay body colors are gray and brown, which are natural colors of soil. It is called stoneware because this type of product is coarse-grained, dense, and very durable. Water and liquids cannot percolate through the texture.

Figure 36 Ceramic, stoneware clay body.
Made by Researcher, 2020.

Stoneware body is similar to earthenware but it is fired at high temperatures and emits more orotund sound when it is knocked. The raw materials of producing must be high heat resistant and have plasticity. When it is fired, the colors of the raw materials turn whatever colors. Stoneware products created from natural soil and molded directly are durable. These example products are Ratchaburi Water Jar and ChiangMai Celadon, etc.

Figure 37 Ceramic, stoneware clay body
display at Gyeonggi Ceramic Museum, South Korea. Photo by researcher, 2012.

Another kind of stoneware products such as food containers, plates, bowls, coffee cups, water jugs, vases, ashtrays, and accessories was usually prepared in the laboratory. Furthermore, acid and alkali resistant containers are relatively thick, dense, opaque, coarse-grained, strong and durable.

2.14.3 Porcelain ware

Porcelain products are vitreous ware specially made by fired kaolin at vitreous point. Porcelain wares are translucent and fired at temperatures above 1250 ℃ (cone 9). The mixture of clay body consists of quartz, feldspar, kaolin, ball clay, and other materials according to the appropriate ratio. When it is fired, it is durable and appeared glassy.

Figure 38 – 39 Ceramic, Porcelain ware.

Source: Gyeonggi Ceramic Museum, South Korea. Photo by researcher, 2012.

Due to the porcelain clay is less cohesive, it can be mostly molded by casting and jiggering processes. The wheel throwing is not the popular process because of the lower plasticity and the preparation of clay body which there are many steps. Usable clay must be respectively handled through the processes of soil washing, mixing, grinding, and separating iron from soil. White porcelain product has fine-grained texture. After it is fired, it is durable, translucent, and less thick. China was the first nation in the world that invented the production of porcelain.

Porcelain products can be categorized by temperature level in firing. Firstly, soft porcelain fired at 1210 - 1,285 ℃ (cone 7 - 11) is popularly made into table wares and artwares. Secondly, the hard porcelain fired at 1310 - 1,431 ℃ (cone 12 - 15) is particularly strong. It is commonly made into tools, electric insulator, electrical equipment such as engine spark plugs, as well as laboratory equipment such as crucibles, basin, etc.

Part 5: Art theories influence in Ceramic Sculpture

2.15 Art theories

Aesthetic is like the breath of art, even if it does not exist, but it is not wrong to call it the spirit of art, the source of thought and power in shaping the framework of creation. Aesthetics or the personal concept of art, of the imperfection or taste, what does it taste like to be beautiful, why does beauty become a wait, but the way an artist thinks is the most important thing (Jamuni, 2017). Art theory for this research as follows:

2.15.1 Organic Theory

2.15.2 Formalist Theory

2.15.3 Experience Theory

2.15.1 Organic Theory

Organic Theory, the main subject of art theory is the composition of sub-components into a large, well-organized structure, which has many similar concepts to those of shape. The distinctive, overall shape, the sub-item, the more important the content, the art definition (Jamuni, 2017).

Figure 40 Henry Moore, Reclining Woman, 1930
, Hornton stone, National Gallery of Canada, Ottawa, Purchased 1956
(Online) Accessed on May 30, 2020. Available from
https://www.nga.gov/features/slideshows/henry-moore.html#slide_3

2.15.1.1 The Harmony of Integrate by Stephen Pepper

The writing by Stephen Pepper, organic criticism is important that the essential characteristic of art is that all parts of the body must be fully integrated (Intergrate) without conflict. The word Organic may also be called Objective idealism, which can be used to define an artistic object. Every detail, every detail, every position, every property, every relationship, no part of it can be cut or altered because it's a violation of balance, fit (Jamuni, 2017).

Figure 41 EASTERNER 1, 1971,
Acrylic on canvas, 117x117 cm. Collection of TISCO Bank Public Company Limited by Sone Simatrang (Online) Accessed on May 30, 2020. Available from *http://www.rama9art org/artisan./6decade/work/workdec3_35.html*

Critics are observant, knowledgeable, and active viewers, who are not silent, watch, and comment, Pepper believes in literary behavior. He said that many viewers have a common sense of beauty, which means that every piece of work is well-matched, not much, not to say not wrong, as Pepper refers to another Bosanquet scholar in the British group, who explains that ugly is "difficult beauty. "The pattern of art is consistent (Jamuni, 2017).

The example Pepper refers to in most literature, he does not mention the artistic or musical approach to this theory. Pepper has the word Aesthetic Consciousness. What is highly valued in this regard is that what is well-matched, as an intellectual criticism, is the artist's ability to link the elements beautifully (Jamuni, 2017).

Figure 42 Huay Fai Sculpture, teak, 1974 – 1977 *The Autonomous Spirit Exhibition* Catalogue (Page 50) by Inson Wongsam, 2014. Bankok: Plan Printing Co.,Ltd.

2.15.1.2 Art Form in Natutre by philosopher Haeckel

Already in the General Morphology of Organisms Haeckel formulated his already mentioned MONISM, a scientific-materialistic philosophy, according to which there is no matter without mind and no mind without matter, but "ONE." BOTH at the same time "and God is identical with the general law of causation of nature itself.

The traditional school philosophy of this time developed its theories in part deliberately in the antithesis of science, whereby Haeckel and others were interested in a scientific foundation of philosophy. Haeckel saw the law of substance as the supreme all-encompassing law of nature as an inseparable unit of the law of the conservation of matter (Lavoisier 1789) and the law of the conservation of force (Robert Meyer 1842). With recourse to Spinoza's concept of substance, he assigned two attributes to this universal substance: matter as space-filling substance and energy as moving force, later the psychoma (sensation) as a third property. In his opinion, this universal substance also embodies the union of "GOD-NATURE".

Figure 43 Marchantia Hepaticae Lebermoose.
(Haeckel, 2017: Page 295)

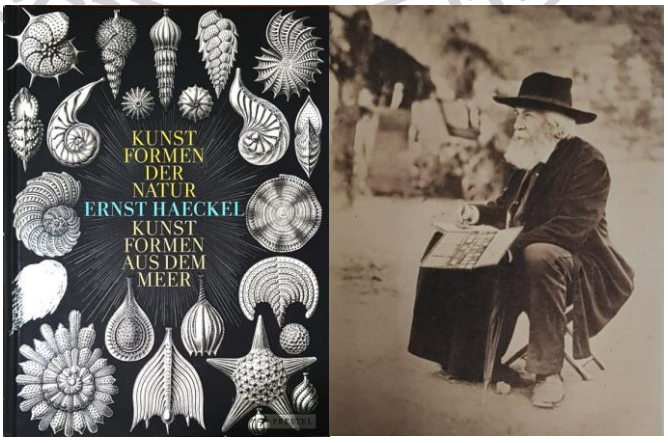
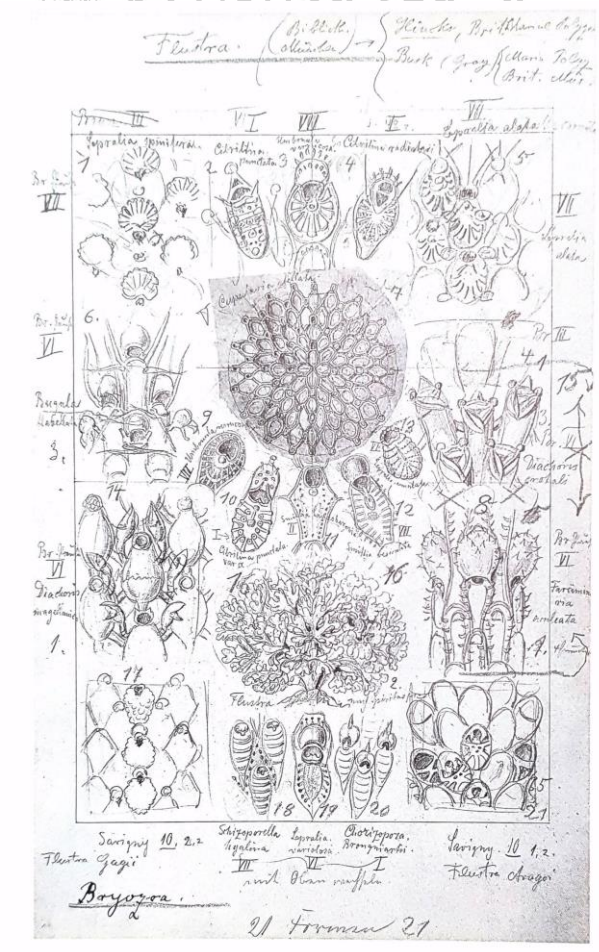


Figure 44 The cover of Ernst Haeckel’s Kunstformen der Natur (Haeckel, 2017: Cover)

Figure 45 Ernst Haeckel in Rapallo (1904). (Haeckel, 2017: Page 9)

What is the cause of the sense of beauty? Haeckel as a pioneer of neurasthenics Haeckel was already looking for a neurobiological explanation for the perception of beauty. For him, the perception of the beauty of the landscape "through the physiological functions of the nerve cells in our cerebral cortex that produce these aesthetic pleasures is one of the most perfect achievements in organic life". The sense of beauty is anchored in "aesthetic neurons" or "sensual brain cells". But he is also astonished: "It is very strange that the absolute irregularity, the lack of symmetry is the first prerequisite for the beauty of the landscape." Haeckel had no answer to that.



3 Bryozoen (Moostiere). Entwurf für Tafel 33 der Kunstformen der Natur

Figure 46 Bryozoa (Moss animals). Draft for panel 33 of the Art Forms of Nature.

(Haeckel, 2017: Page 106)

Finally, he declares an ascending series of developments in the beauty of natural forms "from the simple to the complex", from the lower to the higher, with organic differentiation being decisive. A sea cucumber, an unsightly structure, appears to us to be more primitive and by no means as beautiful as the evolutionarily lower standing state jellyfish, which is highly differentiated. According to Haeckel's view, this corresponds to the development of man's sense of beauty both ontogenetically from child to adult and phylogically from "savage and barbarian to cultural critic". With his considerations on the physiological development of aesthetic sensations, Haeckel is, so to speak, a pioneer of neuroaesthetics (it explains aesthetic sensations on a neural basis). If we as viewers find the radiolarians beautiful, it has something to do with the way our perception apparatus works. Our sensory organs and our central nervous system are genetically programmed as a result of a phylogenetic development in such a way that they are able to recognize regularities and thus order. For an organism, the world must be predictable, otherwise it cannot live in it. The Gestalt psychologist Wolfgang Metzger (1936) spoke in this context of a "sense of order". That is the reason why we find crystals or organisms beautiful, be they bilateral or built with radial symmetry.

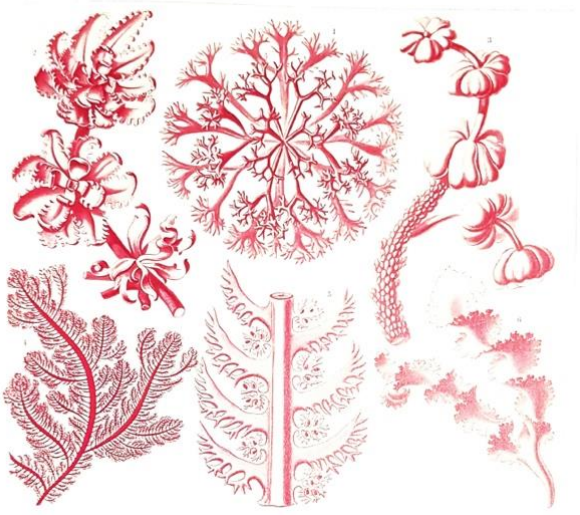


Figure 47 Delesseria Florida red algae. (Haeckel, 2017: Page 261)

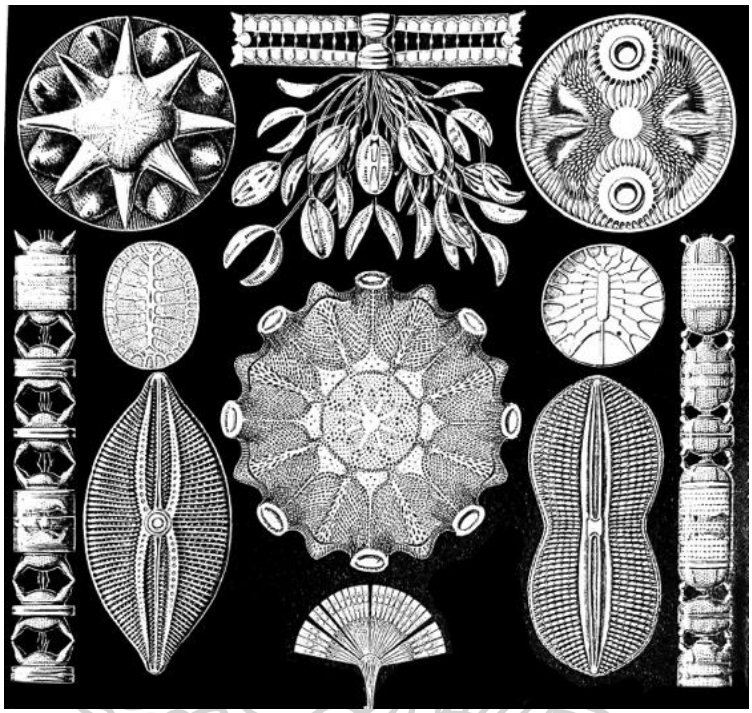


Figure 48 Navicula Diatomea Boxes. (Haeckel, 2017: Page 299)

Whether we perceive something as beautiful or ugly is based, among other things, on innate patterns. Further schemes are newly formed through learning processes of individual and cultural experience. Just think of the child schema described by Konrad Lorenz. Since the face is of great importance for interpersonal communication, it is not surprising that monkeys and humans have their own brain region that is used for face recognition. The positive assessment of plants is a special kind of aesthetic prejudice. Presumably, it reflects an archaic, aesthetic character. Wherever plants thrive, our ancestors found everything they needed to live. In a similar way, we are given an archaic aesthetic preference for a type of landscape in which the incarnation took place, namely that of the savannah. According to studies by E. Synek (1998), the savannah preference is shown mainly in prepubertal age. Then this is superimposed on a secondary preference for the type of landscape in

which one grows up, which is characterized by home. This is an imprint like definition, the neural basis of which is now known.

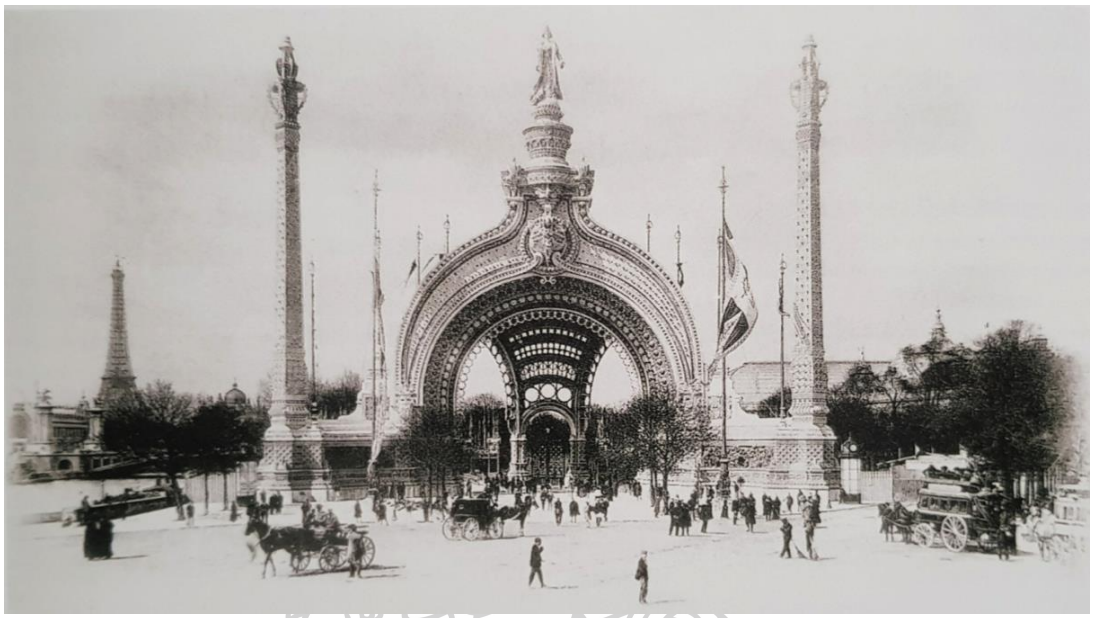


Figure 49 1900 World Fair in Paris: the place de la Concorde and the Monumental Gate. (Haeckel, 2017: Page 24)

2.15.2 Formalist Theory

The aim of this theory is form important than meaning. Form made identity.

2.15.2.1 Clive Bell

Art is the complex structure, whether it be the composition, the form or the line, which is unique to the mass and the space is not easily understood and visual. Art can be summed up as "shape," but the most important thing is a combination of forms, which is clearly in the painting. The artist is trained to see the shape, in some cases the symbol must convey the meaning of the literal meaning, the shape theory is different from the theory of exact imitation without the actual content. Images of people or fruits, but in form, like round, iron, shape theory developed in a rapidly evolving group of abstract artists (Jamuni, 2017).

2.15.2.2 Susan Langer

The so-called forms are different, for example, in painting, the two -dimensional component, the color, in practice, is the mass, the Leela, the dance, the Langer, says the important thing is the shape must express the feelings of the Langer.He's probably a very literary figure, probably a very old one, with a film character, a camera angle, a shape-shifting image in the painting, maybe a leaf tree, The first shadow, the atmosphere in the abstract art, the circular mass, the rectangle, are all shapes.

The word "semblance" or the figure found in Langer's writings means shape, two or three-dimensional shape, or maybe some other quality, because English form is very broad in meaning, which explains Langer's point. Yosh Dickie, the Langer review is that the author uses various form, both true and true, to make the impression that we're in deep water. Because Langer used a pattern that was both real and he designed a mass character, like a tree, fruit, and the author was confused between the two points of creating a shape and making it look real, creating a confusion between imitation and focusing on the main point of figure 6.3.3.This man plays an important role as a literary and critical figure in the rapidly evolving age of the arts. There are many experiments to find new ideas and shapes that are being born in the art world in the mid-20th century, the United States being the center of the nation (Jamuni, 2017).

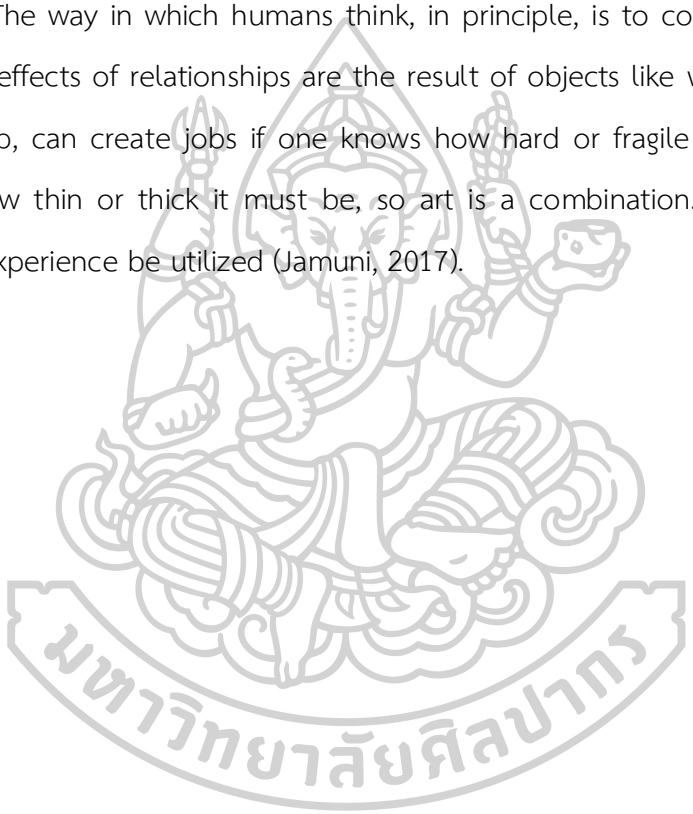
2.15.2.3 Experience Theory

John Dewey has not denied making a choice or a similar one, but Dewey believes that experience is the most important thing. So no wonder Dewey's way of thinking is based on analytic language, his philosophy says that experience is not

structural or framed, but rather like the belly of a field where all human activities live.

The author extends that if fish have to live in water, birds in the air, humans should be in the realm of experience, whether in the city or in the countryside, in our professional home or in our professional establishment (Jamuni, 2017).

The reason is that the harvest is both beneficial and constraint, like a livelihood. The way in which humans think, in principle, is to consider, starting with poetry, the effects of relationships are the result of objects like wood, knowing how to cut sheep, can create jobs if one knows how hard or fragile the relationship is, planning how thin or thick it must be, so art is a combination. How can the rich harvest of experience be utilized (Jamuni, 2017).



Chapter 3

RESEARCH METHODOLOGY

The research projects “Exploring the tropical fruits waste as ash glaze for organic ceramic sculpture” focuses on the techniques and procedures for generating glaze from ash for ceramics creation. Ash glazes are often produced from wood ash. Wood kilns are becoming less prevalent due to a scarcity of essential resources such as wood. Moreover, Thailand is the main area for tropical fruits producer and exporter in the world. As a result, the researcher recognized that tropical fruits ash might be used to make ceramics. This research investigated the use of agricultural waste from tropical fruits waste to produce ash glaze.

3.1 Methodology

This research aimed to use tropical fruits waste and transform them into ash glaze. The methods and procedures are as follows.

1. Collected tropical fruits from the shops and the trashes.
2. Dried out tropical fruits.
3. Fired tropical fruits to make the ash at 800 ℃.
4. Mixed the tropical fruits ash, soda feldspar, and soil together following the 21-point Triaxial Blend theory, then coat the sample plates with the glaze.
5. Fired the test plates at 1222 ℃.
6. Analyzed the experimental results by observing the various test plates and selected the formula of ash glaze for testing on ceramic works.
7. Applied the tropical fruits ash glaze on the ceramics.

3.2 Process data collection

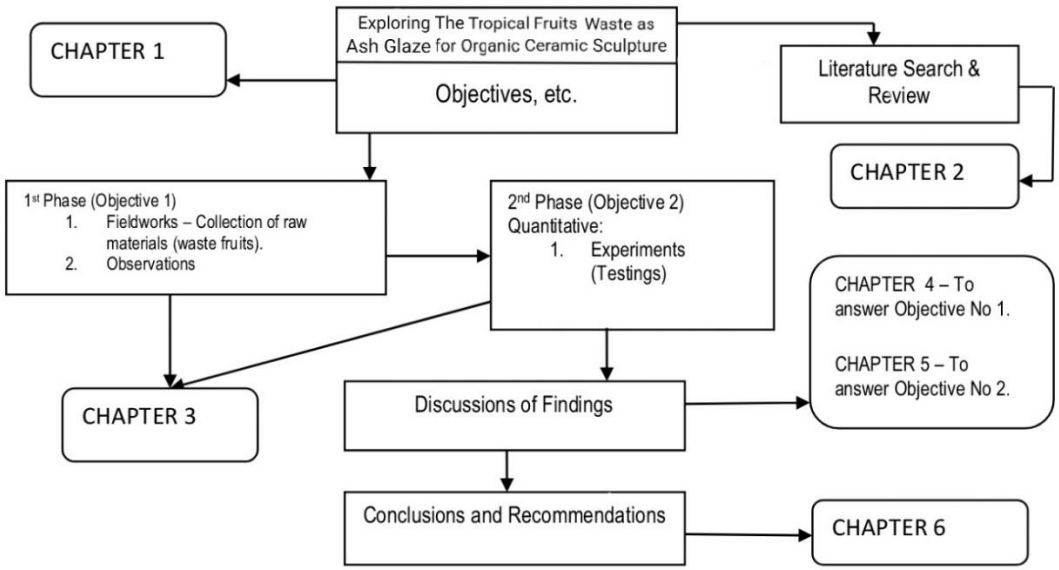


Figure 49 Process data collection diagram.

Advice by Professor Mustaffa Halabi HJ. Azahari, Ph.D.

3.3 Research Area

The following criteria were used to define the scope of this study:

3.3.1 Used tropical fruits waste as a source of raw materials for testing.

3.3.2 Researched and studied the history and philosophy of ash covering for making fruit ash glaze.

3.3.3 Created the new dada of fruits ash glaze to glazing with ceramic creation.

3.3.4 Demonstrated the possibilities for glazing ceramic pieces with fruit ash glaze.

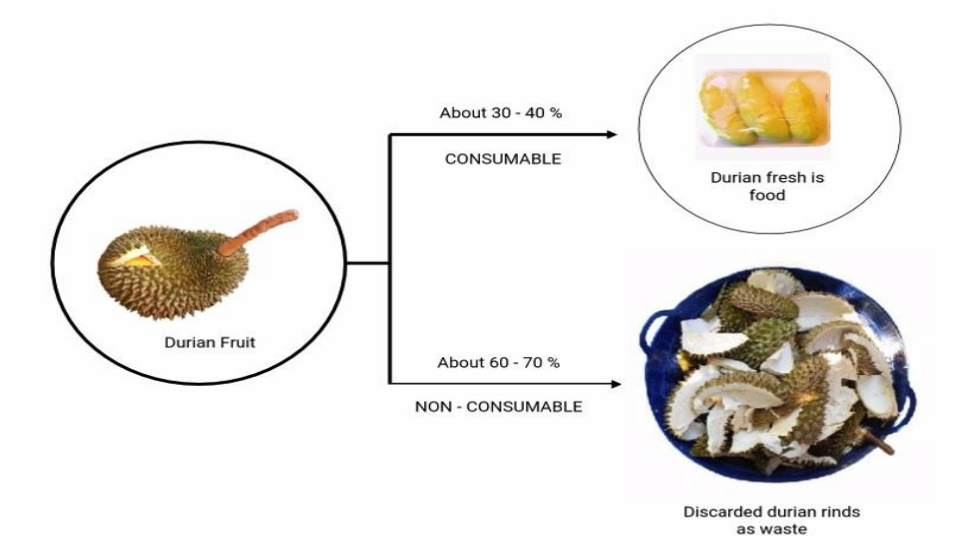


Figure 51 Parts of a durian fruit. Diagram by Researcher, 2018.

Figure 51 The researcher collected raw materials (Durian rind) to conduct the research.

3.4 Process of fruit waste ash glaze making.

3.4.1 Gathering up raw materials from the market or garden.





Figure 53 – 57 The researcher collected raw matterials to do the research.

Photos by Kanyarat Muangkaew, 2019.

3.4.2 Dried the raw materials on the clean cement courtyard for 2 weeks.

Figure 58 - 60 The Researcher dried raw tropical fruits.

Photos by Warawut Tourawong, 2019.

3.4.3 Burning raw materials into ash.

Figure 61 - 62 Put dried durian rinds into a pot for firing in the kiln at 800 °c.

Figure 62 Put Durian rinds into in to kiln.

Figure 63 Durian Ash after firing at 800˚c

3.4.4 21-Point Triaxial Blend Diagram.

The Triaxial Blend theory was used to calculate a glaze formula. It is a method for determining the ratios of the basic compositions of glaze which there are 3 or more kinds. This glaze formula is more fused than others that use only 2 kinds of compositions. Moreover, the glaze formula calculation of the Triaxial Blend theory will be got more various glaze properties, including the diversity of textures and colors. For instance, opaque- transparency, and gloss- matte. There are more optional glazes if there are several colors. Each 10% or 20% differences of composition ratios are determined by the Triaxial Blend. The ratios of compositions could be available at 21, 36, 66 points, or more than 66 points.

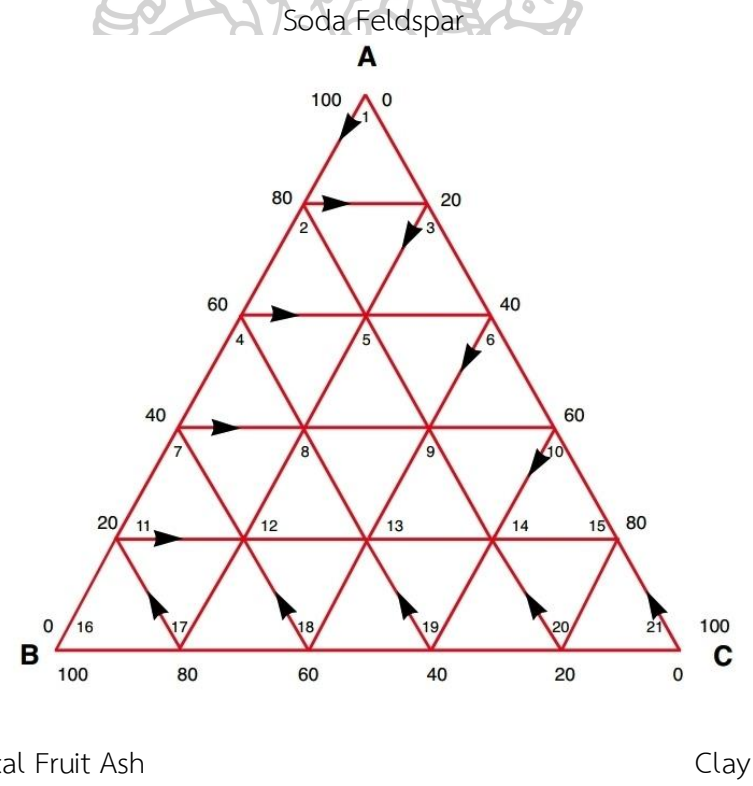


Figure 65 There is a total of 21 points that determine each 20% differences of composition ratios. The ratios of compositions “A” are termed A-B, “B” is termed B-C, and “C” are termed C-A (A= Soda Feldspar / B= Fruit Ash / C= Clay

1 A : 100 % B : 0 % C : 0 %	**2** A : 80 % B : 20 % C : 0 %	**3** A : 80 % B : 0 % C : 20 %	**4** A : 60 % B : 40 % C : 0 %	**5** A : 60 % B : 20 % C : 20 %	**6** A : 60 % B : 0 % C : 40 %	**7** A : 40 % B : 60 % C : 0 %
8 A : 40 % B : 40 % C : 20 %	**9** A : 40 % B : 20 % C : 40 %	**10** A : 40 % B : 0 % C : 60 %	**11** A : 20 % B : 80 % C : 0 %	**12** A : 20 % B : 60 % C : 20 %	**13** A : 20 % B : 40 % C : 40 %	**14** A : 20 % B : 20 % C : 60 %
15 A : 20 % B : 0 % C : 80 %	**16** A : 0 % B : 100 % C : 0 %	**17** A : 0 % B : 80 % C : 20 %	**18** A : 0 % B : 60 % C : 40 %	**19** A : 0 % B : 40 % C : 60 %	**20** A : 0 % B : 20 % C : 80 %	**21** A : 0 % B : 0 % C : 100 %

Table 1 : Triaxial Blend formula/Percentages of FruitsAsh glaze in 21 Point.

3.4.5 Equipment for weighing and grind mix raw materials.

Figure 65 A scale for weighing raw materials.

Photo by researcher, 2029.

Figure 66 A mortar and pestle.

for mixing pottery glazes.

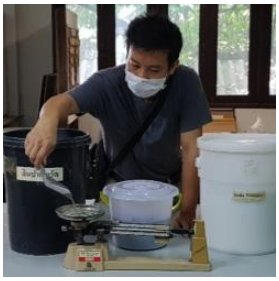


Figure 67 Weighed raw materials according to the formula.

Figure 69 Raw materials for making glaze (Soda Feldspar, Fruit Ash, and Clay).

Percentages of the raw materials depend on 21- Point Triaxial Blend.

Figure 70 Mixed water into the raw materials. Photo by researcher, 2019.

Figure 71 - 73 Painted glaze on earthenware and stoneware clay body test plates.

Photo by researcher, 2019.

Figure 73 Put test pieces into the kiln for firing at 1,222˚c.

Photo by Researcher, 2019.

Figure 74 Adjust the klin temperature at 1,220˚c.

Photo by Researcher, 2019.

Chapter 4

EXPLORING ASH GLAZE FROM TROPICAL FRUITS WASTE

This chapter shows the result of ash glaze from tropical fruits. When the seasonal fruits were mature, they fell under the trunks. For this reason, the researcher collected these following fruits to use as raw materials in this study. All test plates that are applied with tropical fruits ash glaze can be utilized depending on the purpose. For example, the Durio zibethinus Murray rind ash glaze that coats the food container should be glossy for the convenient cleaning. The glaze of artworks or decorative pieces must be selected based on color and texture that are appropriate for individual ceramic form. It is related the following tropical fruits ash glaze from:

4.1 Cassia fistula

4.2 Coffea arabica L.

4.3 Delonix regia

4.4 Durio zibethinus Murray

4.5 Garcinia mangostana linn

4.6 Lagerstroemia floribunda

4.7 Litchi chinensis

4.8 Nipa fruticana

4.9 Peltophorum pterocarpum

4.10 Shorea robusta

4.11 Sterculia foetida

4.12 Terminalia catappa

4.13 Xylia xylocarpa

4.1 Cassia fistula

Common name: Golden shower, Indian laburnum, Pudding-pine tree, Purging cassia

Scientific name: Cassia fistula L.

Family name: Caesalpinioideae, Caesalpiniaceae

Figure 75 Cassia fistula at Silpakorn University Sanamchadra Palace Campus, Thailand. Photo by Researcher, 2018.

Botanical characteristics:

Stem: It is a native plant in South Asia; southern Pakistan to India, Burma and Sri Lanka. It is classified as medium-sized plants. The trunk has a smooth grayish-brown color. It usually grows in deciduous forests or in soil with good water transfer. Propagated by seed and transplanted seedlings into nursery bags. When grown enough, then moved to plant in the area. However, it may be used to graft and plug the top at present but the chance of success is less than the seed method.

Leaf: The appearance of the leaves into a bouquet glossy green leaves. Each bouquet is about 2.5 cm long and has 3-6 pairs of ovate or fortified leaflets. The leaflets are 5-7 cm wide and 9-15 cm long. The base is rounded and examined towards the end of the leaf. Thin leaf texture has frequent leaf veins and curves along the shape of the leaves.

Flower: A bouquet of flowers, about 20-45 cm long, with parallel edges. It is about 1 cm long and has 5 petals that fall off easily. And the petals are 2-3 times longer than the secondary petals and have 5 oval petals around the petals, the petal line is clearly visible where the flower has stamens 10 stalks of different sizes, with an anther stalk curved upwards. The flowers usually bloom between March and May but there are some cases that bloom outside the season as well, such as from December to January.

Fruit: The fruit is a neat cylindrical pod, about 20-60 cm long and about 2-2.5 cm in diameter. Young pods are green. The pods are arranged to be black. The sheath has a thin membrane attached to it. There are flat brown seeds, about 0.8-0.9 centimeters in the cavity.

Utilization: To treat various diseases and symptoms. The parts used as medicinal properties include the leaves, flowers, bark, pods, sapwood, roots and seeds. It is the herb that can be used for both children, women, and the elderly without any danger.

Figure 77 Cassia fistula fruit. Photo by Researcher, 2018.

4.1.1 Cassia fistula with chemical analysis.

Dry Cassia fistula (ผลราชพฤกษ์)		**Cassia fistula Ash** (เถ้าผลราชพฤกษ์)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	1.46
MgO	Magnesium Oxide	0.885
Al_2O_3	Aluminum Oxide	0.154
SiO_2	Silicon Oxide	0.701
P_2O_5	Phosphorus Penoxide	0.944
K_2O	Potassium Oxide	6.248
CaO	Calsium Oxide	1.618
MnO	Maganese Oxide	0.019
Fe_2O_3	Iron Oxide	0.038
CHO	Carbohydrate	87.933

Table 2 : Dry-Cassia fistula and Cassia fistula-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.1.2 Cassia fistula ash glaze chart tests.

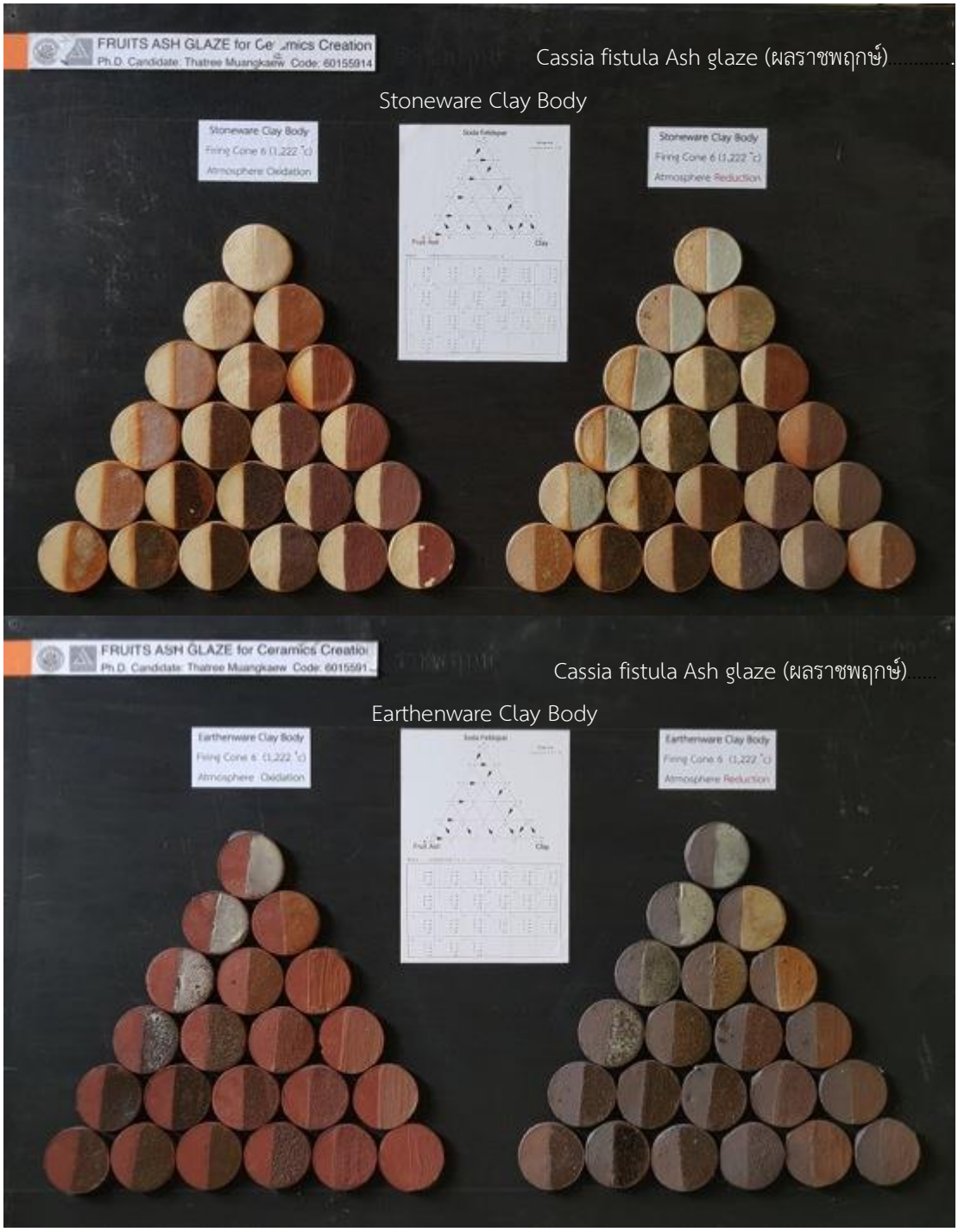


Figure 77 Triaxial blend glaze testing with Cassia fistula Ash.

Photo by Researcher, 2019.

4.2 Coffea arabica L.

Scientific name: Coffea robusta Pierre ex Froehner L.

Family name: Rubiaceae

Genus: Coffea

Species: C. Canephora

Common name: Robusta Coffee

Figure 78 Illustration of Coffea arabica plant and seeds
(Online) accessed April 28, 2020, available from *https://th.wikipedia.org/wiki/%E0%B8%81%E0%B8%B2%E0%B9%81%E0%B8%9F#/media/ไฟล์:Coffea_arabica_-_Köhler–s_Medizinal-Pflanzen-189.jpg*

Botanical characteristics:

Root: Coffee with taproot and have branched roots separated from the taproot, about 4 to 8 roots; and from the root fuzz, there will be another root which is a root for sucking food. This type of root is approximately 60 to 80 percent spread at the soil surface depth of about 20 centimeters.

Stem and Branch: Main Stem is a stem that grows from a taproot. It i characterized by joints to joints. While the coffee tree is still small, it is noticeable. The leaves are located along the joints of the trunk. As the plant grows, the leaves fall off. And at the base of the coffee leaf there are 2 types of buds: the upper bud and the lower bud. The upper buds will branch out into the first branch (Primary Branch) is a branch that looks like a branch lying parallel to the ground with joints

and joints. Each branch of this branch has a cluster of flower buds that will flower. It is the next coffee. The lower buds are broken into branches (Sucker). Branches are erected upright like the trunk, not flowering, but can create branches that can produce flowers called the 1st branch as well. The 1st branch can be further branched into the 2nd branch and the 2nd branch can be branched into the 3rd branch again. These branches are formed in pairs, alternating, opposite each other on the trunk or branches. When the coffee stems are cut The lower buds on the trunk will branch up. The erect branches are branched into the 1st, 2nd and 3rd branches, and then produce longer flowers and coffee fruit.

Figure **79** Coffee tree at Chumphon Horticultural Research Center (Online) accessed April 28, 2020, available from *http://www.doa.go.th/hc/chumphon/?p=621*

Inflorescence and Flower: Coffee flowers are usually single, sexually mature, with 4 to 9 petals, 4 to 5 sepals, 5 stamens, 2 ovaries, each chamber of the ovary contains 1 egg therefore coffee has 2 beans. It will go out in groups at the base of the upper leaf. The joints of the first branch, the second or the third branch, each

flower cluster has 2 to 20 flowers, depending on the abundance of buds. The flowers will depart from the branches from the joints near the trunk to the ends of the branches. Coffee usually flower according to the joints of the branches. The one that bears fruit the following year will not bear flowers and fruits.

Fruit and Seed: The fruit of coffee is similar to a ball, oval, short stem, raw green fruit, when ripe, it is yellow, orange, and red. The fruit of the coffee is divided into 3 parts: 1.) Skin 2.) Pulp that is yellow and sweet taste when it is ripe, and 3.) Parchment that will envelop the seeds. There is a thin membrane between the seed and the shell. The seed coat is called Silver Skin. Each coffee has two seeds. The articulated side is flat inside. There is one groove in the middle of the seed. The outer part is curved. Seeds are single (pea bean, and pea berry). If pollination is sometimes incomplete, it will has only one seed. Coffee has only one, round, and oval bean with a groove in the middle of 1 groove. (Department of Agronomy, Faculty of Agriculture, Kasetsart University ; Department of Agriculture)

Figure 80 Coffee been from dry to roast.
(Online) accessed April 24, 2020, available from
https://www.giesencoffeeroasters.eu/the-basics-of-roasting-coffee-beans/

4.2.1 Coffea arabica L. with chemical analysis.

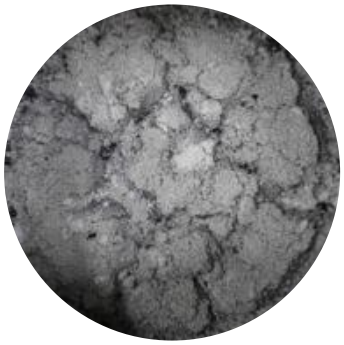
Dry Coffea arabica L. (ผลกาแฟ)		**Coffea arabica L. Ash** (เถ้าผลกาแฟ)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	5.103
MgO	Magnesium Oxide	10.956
Al_2O_3	Aluminum Oxide	0.303
SiO_2	Silicon Oxide	0.319
P_2O_5	Phosphorus Penoxide	8.557
K_2O	Potassium Oxide	14.247
CaO	Calsium Oxide	5.906
MnO	Maganese Oxide	0.269
Fe_2O_3	Iron Oxide	0.291
CHO	Carbohydrate	54.048

Table 3 : Dry-Coffea arabica L. and Coffea arabica L.-Ash with Chemical Analysis by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D. Department of Materials Science and Engineering, Faculty of Engineering and Industrial Technology, Silpakorn University. Photo by Researcher, 2019.

4.2.2 Coffea arabica L. ash glaze chart tests.

Figure 81 Coffea arabica L. Ash by Line blend glaze testing.

Photo by Researcher, 2019.

4.3 Delonix regia.

Common name: Flam-boyant, The Flame tree, Royal poinciana

Scientific name: Delonix regia (Hook.) Raf.

Family name: Fabaceae, Leguminosae.

Figure 82 Delonix regia Tree (Online) accessed April 24, 2020, available from *https://www.etsy.com/listing/534042691/25-seeds-delonix-regia-flame-tree-royal*

Botanical characteristics:

Stem: It was discovered in 1824 by Australian botanist, Wenzel Bojer, in Madagascar, Africa. It is a medium-sized perennial plant. When the tree is fully grown, it has a height of about 12-18 meters with a broad canopy spread like an umbrella and spreading its branches like a Chamchuri tree but will be smaller Guava guppy stem. The trunk is clean. The bark is light brown, white to dark brown. The base of the tree is buttress. When the plant is mature, roots tend to emerge on the surrounding soil. The guava tree is propagated mainly by seed method.

Leaf: The appearance of the leaves is composed of two feathers arranged alternately and have leaflets arranged opposite each other. The size of the leaves are similar in size to the tamarind leaves. The leaf plates are oblong. The tip is round, the base is warped, and the leaf surface is smooth. The guava guppy is a deciduous plant which usually sheds leaves during March to June.

Figure 84 Delonix regia pod on Tree at Silpakorn University Sanamchadra Palace Campus, Thailand. Photo by Researcher, 2019.

Flower: Inflorescence flower at the end of the branch and at the leaf axle near the end of the branch. The flowers consist of five petals, with a long stamen that protrudes above the petals. The petals consist of two colors, red and yellow. It may be seen which flower is more yellow. The flowers are a yellow expression, but if any flower is redder. It will be a red expression. There are some guppy guava that can bloom in true red color and true yellow guava flower as well but it's hard to find. The flower will bloom and leave the leaves under the plant, leaving only the one that blooms make it look beautiful. In Thailand, the flowering season of the guava guppy during April to May.

Fruit: The fruit is a hard flat and curved pod. It is about 30-60 cm long and 3-5 cm wide. The appearance of the pod is a joint when the pod is broken. There are about 20-40 seeds in the pods arranged crosswise. The young seeds are green. The mature seeds are grayish-white, rather spherical in appearance.

Figure 85 Delonix regia pod. Photo by Researcher, 2018.

4.3.1 Delonix regia with chemical analysis.

Dry Delonix regia (ฝักหางนกยูงฝรั่ง)		**Delonix regia Ash** (เถ้าฝักหางนกยูงฝรั่ง)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	1.65
MgO	Magnesium Oxide	2.776
Al_2O_3	Aluminum Oxide	0.678
SiO_2	Silicon Oxide	3.719
P_2O_5	Phosphorus Penoxide	1.272
K_2O	Potassium Oxide	8.077
CaO	Calsium Oxide	6.917
MnO	Maganese Oxide	0.017
Fe_2O_3	Iron Oxide	0.127
CHO	Carbohydrate	74.769

Table 4 : Dry-Delonix regia and Delonix regia-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.3.2 Delonix regia ash glaze chart tests.

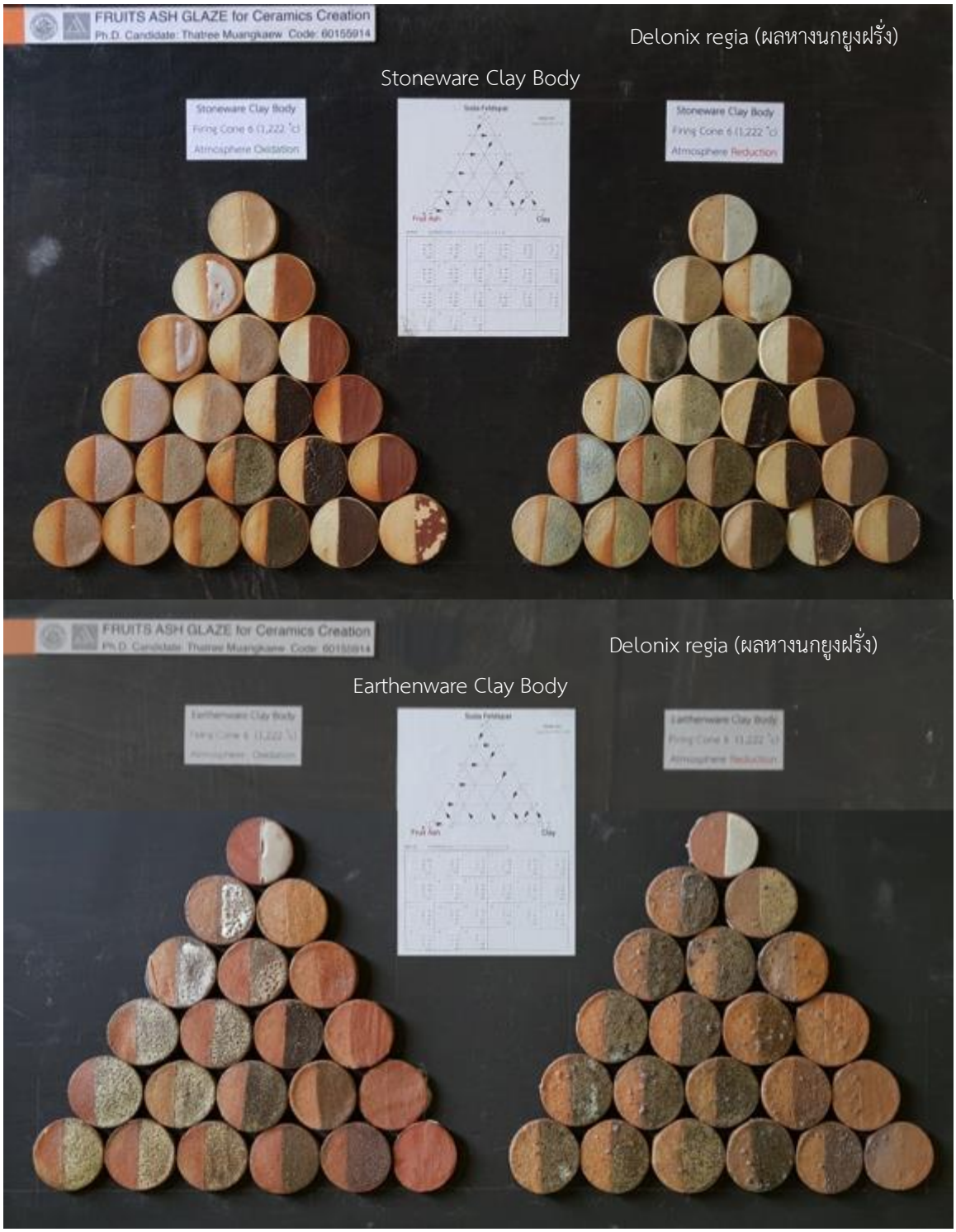


Figure 84 Triaxial blend glaze testing with Delonix regia Ash.

Photo by Researcher, 2019.

4.4 Durio zibethinus Murray

Scientific name: Durio ziberhinus Murray.

Family name: Bombacaceae.

Common name: Durian.

Figure 85 Durio ziberhinus Murray.
Photo by Researcher, 2018.

Botanical characteristics:

Stem: It is about 10-15 meters tall, straight trunk, branching from the surrounding trunk. The canopy is spherical or pagoda-shaped. Its husk is gray or reddish brown.

Leaf: It is a single and glossy green leaf. The underside of the leaf is brown. The leaf tip is pointed. The leaf margin is oblong and smooth. The petiole is plump.

Flower: Clumps, off-white, hanging on branches, fragrant, 4-5 petals.

Fruit: Round or oval with thorns green or yellowish green, solid all over the ball strong smelling meat.

Seed: The appearance in the middle is bloated and the head is rounded. Relatively large seeds 2-4 cm in diameter. The mature seeds are yellowish-brown or reddish-brown. It is covered with thin membrane.

Figure 86 Durio ziberhinus Merray.

Photo by Researcher, 2018.

Utilization

Root: To cure the fever, diarrhea, and diarrhea.

Leaf: To drive parasites, cure jaundice, dry pus.

Fruit: Can be taken orally Cure colic in the stomach Cure scurvy Drives worms, nourishes the energy

Rind: Cure ringworm, heal wounds, cure abscesses, and treat skin diseases (Samitinan, 2539)

Figure 87 Dry Durio ziberhinus Murray peel.

Photo by Researcher, 2018.

From the article “Current trends of tropical fruit waste use” by Choon Yoong Cheok, Noranizan Mohd Adzahan, Russly Abdul Rahman, Nur Hanani Zainal Abedin, Norhayati Hussain, Rabiha Sulaiman and Gun Hean Chong (2016) in “Critical Reviews in Food Science and Nutrition”, it mentioned the problem of waste from durian rind that 60 - 81 % of inedible durian parts are rind and seed causing a lot of wastes. Moreover, the researcher found that there are more than 100 tons of fruit waste from durian rinds in Nakhon Pathom province, where is the residence of the researcher, as well as Chiang Mai. Those fruit waste caused by the popular consumption of local people and tourists. It becomes the big problem for the municipality in ***waste*** disposal. Therefore, the municipality provided waste from durian rind to make fertilizers and distribute to the people.

Figure 88 Durio ziberhinus Murray tree.

Photo by Thepparit Chuakhum. 2019.

4.4.1 Durio zibethinus Murray with chemical analysis.

Dry Durio zibethinus Murray (เปลือกทุเรียนแห้ง)		**Durio zibethinus Murray Ash** (เถ้าเปลือกทุเรียน)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	2.578
MgO	Magnesium Oxide	6.368
Al_2O_3	Aluminum Oxide	0.094
SiO_2	Silicon Oxide	2.417
P_2O_5	Phosphorus Penoxide	5.34
K_2O	Potassium Oxide	15.034
CaO	Calsium Oxide	2.862
MnO	Maganese Oxide	0.035
Fe_2O_3	Iron Oxide	0.14
CHO	Carbohydrate	65.131

Table 5 : Dry-Durio zibethinus Murray and Durio zibethinus Murray-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.4.2 Durio zibethinus Murray ash glaze chart tests.

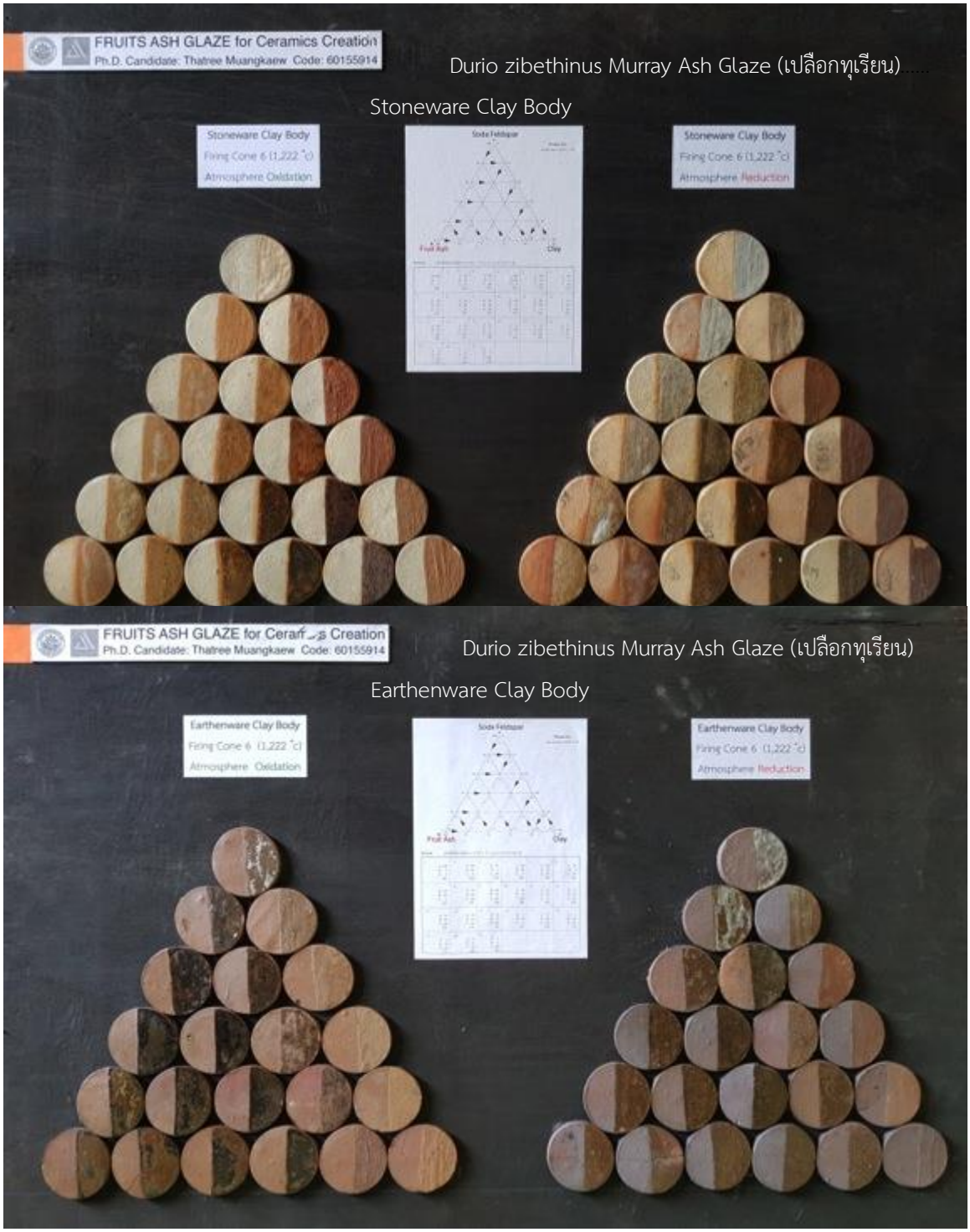


Figure 89 Triaxial blend glaze testing with Durio Ash.

Photo by Researcher, 2019.

4.5 Garcinia mangostana linn

Scientific name: Garcinia mangostana L.

Family name**:** Clusiaceae

Common name**:** Mangosteen

Figure 90 Illustration from Fleurs, Fruits et Feuillages Choisis de l'Ile de Java1863–1864 by Berthe Hoola van Nooten (Pieter De Pannemaeker lithographer) (Online) accessed April 28, 2020, available from *https://en.wikipedia.org/wiki/Mangosteen#/media/File:Berthe_Hoola_van_Nooten48.jpg*

Botanical characteristics:

Stem: Stem upright, bark dark brown to black. Inside the shell consists of latex tubes that look yellow.

Figure 91 Garcinia mangostana L.

Photo by Researcher, 2018.

Figure 92 Mangosteen tree (Online) accessed April 28, 2020, available from *https://en.wikipedia.org/wiki/Mangosteen#/media/File:Pokok_manggis.jpg*

Leaf: It has an elongated shape with a length of about 9-25 centimeters, a width of about 4.5-10 centimeters. Its top is dark green, while the bottom is yellowish green. Leaf plate slightly curved. There are side eyes in the axillary area and the buds are located in the axils of the last pair.

Figure 93 Mangosteen painting (Online) accessed April 28, 2020, available from *https://en.wikipedia.org/wiki/Mangosteen_painting#/media/File:Pokok_manggis.jpg*

Flower: It is single and in some conditions may be flower clusters which flowers appear at the tip of the branches with male inflorescences and female flowers in the same flower but the stamens are sterile. Mangosteen flowers consist of 4 sepals, 4 rather thick petals, stamens at the base around the ovary. It has 3.4-7.5 cm diameter, 6-10 cm thick peel, flesh white opaque. The appearance of the outer rind is green and yellow. There is a yellow rubber inside.

Seed: Each fruit contains about 1-6 seeds. The seeds are about 2.5 centimeters long and 1.6 centimeters wide.

Figure 94 Purple mangosteen fruit.

Photo by Researcher, 2019.

Utilization:

Fresh fruit: To eat

Rind: The dried fruit bark contains tannins used as an astringent to cure diarrhea chronic diarrhea and intestinal diseases. (Tropical Fruit and Perennial Plant Research Center, Research Center Group, Research and Service Department, Faculty of Natural Resources, Prince of Songkla University)

Figure 95 Dry Mangosteen accessed July 28, 2019.

Photo by Researcher, 2018.

4.5.1 Garcinia mangostana linn with chemical analysis.

Garcinia mangostana linn (ผลมังคุด)		**Garcinia mangostana linn Ash** (เถ้ามังคุด)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	2.769
MgO	Magnesium Oxide	0.925
Al_2O_3	Aluminum Oxide	0.286
SiO_2	Silicon Oxide	0.677
P_2O_5	Phosphorus Penoxide	0.911
K_2O	Potassium Oxide	10.555
CaO	Calsium Oxide	1.009
MnO	Maganese Oxide	0.029
Fe_2O_3	Iron Oxide	0.049
CHO	Carbohydrate	82.791

Table 6 : Dry-Garcinia mangostana linn and Garcinia mangostana linn-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.5.2 Garcinia mangostana linn ash glaze chart tests.

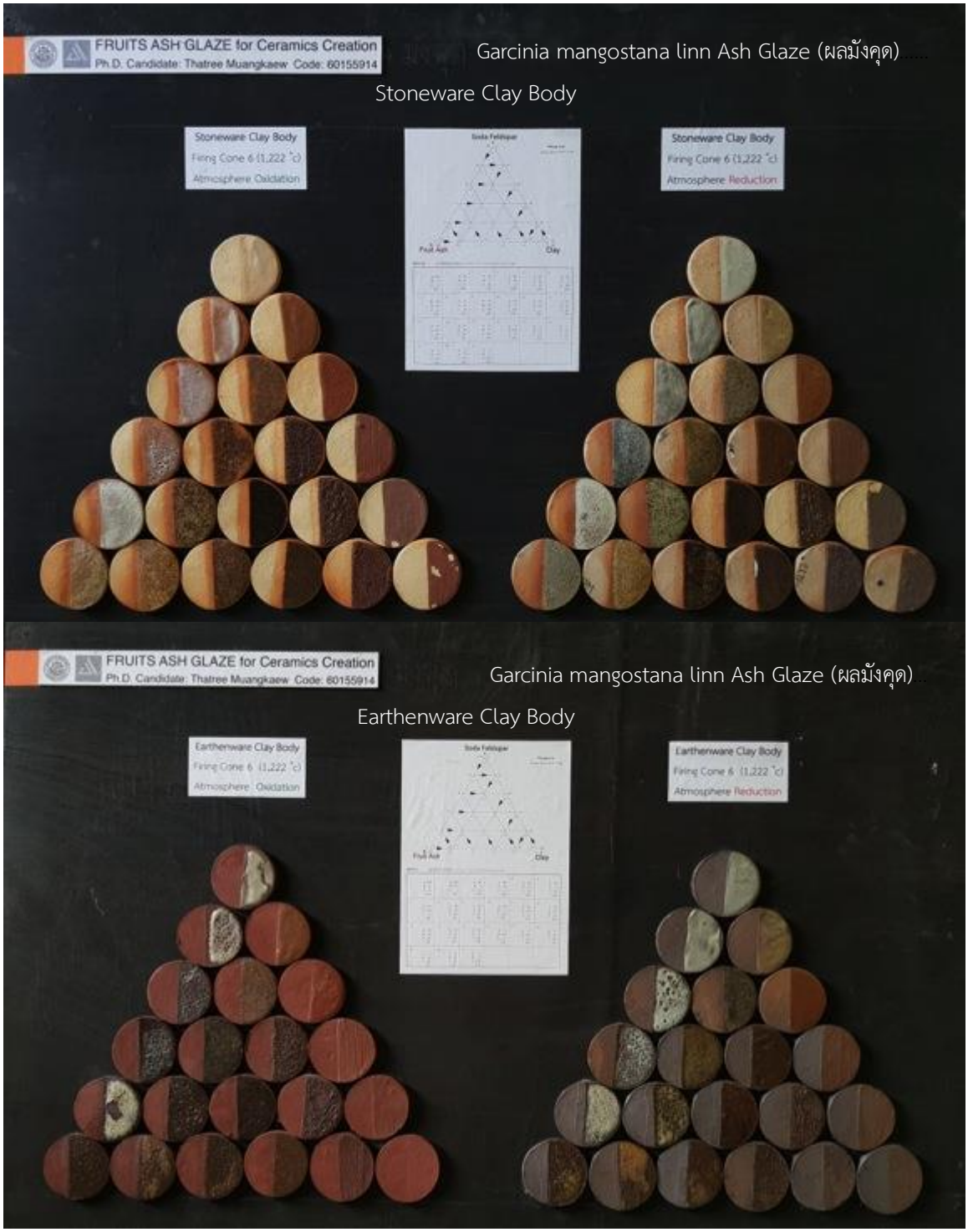


Figure 96 Triaxial blend glaze testing with Garcinia mangostana linn Ash.

4.6 Lagerstroemia floribunda.

Scientific name: Lagerstroemia floribunda.

Family name: Lytheraceae.

Common name**:** Queen's Flower.

Figure 97 Thai Crape Myrtle Lagerstroemia floribunda. (Online) accessed April 28, 2020, available from *https://en.wikipedia.org/wiki/Lagerstroemia_floribunda#/media/File:Flowers_close-up_I_IMG_8701.jpg*

Botanical characteristics:

Stem: It is a medium-sized tree, 2 0 meters tall, a smooth white tree with scaly cracks for the growth of the tree.

Leaf: Green, width 4 cm, length 8 - 9 cm, pointed leaf tip, smooth leaf margin, and thick and rounded leaf base.

Figure 98 Thai Crape Myrtle Lagerstroemia floribunda.
(Online) accessed April 28, 2020, available from
http://dongluangwittaya56.blogspot.com/2013/11/blog-post.html

Flower: It looks like a pink purple bouquet. A perfect flower has grayish-green sepals.

Fruit: It looks like a bouquet out together as a small fruit. When the fruit is fully mature, it will be split into 6 fissures.

Seed: Small black seed came out according to the cracks of the fruit.

Utilization: The wood is made into the handles of tools.

Figure 99 Dry Thai Crape Myrtle Lagerstroemia floribunda. Photo by Researcher, 2018.

4.6.1 Lagerstroemia floribunda with chemical analysis.

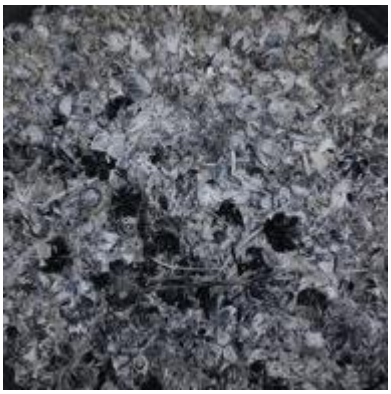
Dry Lagerstroemia floribunda (ผลตะแบกนา)		**Lagerstroemia floribunda Ash** (เถ้าตะแบกนา)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	1.136
MgO	Magnesium Oxide	0.69
Al_2O_3	Aluminum Oxide	0.163
SiO_2	Silicon Oxide	2.373
P_2O_5	Phosphorus Penoxide	0.554
K_2O	Potassium Oxide	10.921
CaO	Calsium Oxide	1.388
MnO	Maganese Oxide	0.022
Fe_2O_3	Iron Oxide	0.065
CHO	Carbohydrate	82.687

Table 7 : Dry-Lagerstroemia floribunda and Lagerstroemia floribunda-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.6.2 Lagerstroemia floribunda ash glaze chart tests.

Figure 100 Line blend glaze testing with Lagerstroemia floribunda Ash, 2019.

4.7 Litchi chinensis.

Scientific name**:** Litchi chinensis sonn.

Genus**:** Nephelium

Family name**:** Sapindaceae

Common name**:** Litchi, Lichee, Laichi, Leechee, Lychee

Figure 101 Lychees (Litchi chinensis). Photo by Researcher, 2018.

Botanical characteristics:

Stem: It is the same genus as rambutan and longan. It can live for 5-25 years or more. It has no leaves and has a medium height. The trunk is about 10-15 meters high or more. The trunk is relatively low branching. Branches are long many branches making it look like a dense, spherical canopy. The bark of the trunk is grayish brown and rough.

Leaf: Litchi leaves are compound leaves. It has a main petiole 10-20 cm long, each petiole has 2-10 leaflets that are split sideways, arranged alternately. Leaves are lanceolate, elongated, lanceolate, apex pointed, leaf plates smooth, leaf plates thick and sticky like a leather. Young leaves or young buds are reddish. The older leaves are dark green and glossy. The undersides are grayish-green that is lighter than the upper leaf.

Figure 102 Lychee tree. *(Online) accessed April 28, 2020, available from https://commons.wikimedia.org/wiki/Litchi_chinensis#/media/File:Wild_lychee_tree_in_Hainan_-_01.JPG*

Flower: Litchi flowers thrust into a bouquet at the end of the branch or the top. They have a 10-30 cm long peduncle. Each inflorescence consists of many flowers. Flowers 3-5 mm. peduncle about 1.5 mm long. Flowers 4-5 sepals. Petals are absent. Yellowish-green, cup-shaped, with 5-10 stamens, and the innermost layer is the pistil with stamens and ovaries. The ovary has 2 lobes, but only 1 lobe will be in effect.

Figure 103 Dry Lychees. Photo by Researcher, 2018.

4.7.1 Litchi chinensis with chemical analysis.

Dry Litchi chinensis (ลิ้นจี่แห้ง)		**Litchi chinensis Ash** (เถ้าลิ้นจี่)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	4.207
MgO	Magnesium Oxide	7.136
Al_2O_3	Aluminum Oxide	0.003
SiO_2	Silicon Oxide	1.03
P_2O_5	Phosphorus Penoxide	7.159
K_2O	Potassium Oxide	7.198
CaO	Calsium Oxide	4.473
MnO	Maganese Oxide	0.013
Fe_2O_3	Iron Oxide	0.093
CHO	Carbohydrate	68.688

Table 8 : Dry-Litchi chinensis and Litchi chinensis-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.7.2 Litchi chinensis ash glaze chart tests.

Figure 104 Line blend glaze testing with Litchi chinensis Ash

Photo by Researcher, 2019.

4.8 Nipa fruticana

Scientific name: Nypa fruticans Wurmb

Common name: Nypa, Atap palm, Nipa, Mangrove palm

Family name: Arecaceae

Figure 105 A globular fruit cluster of the nipa palm.
Photo by Researcher. 2018.

Botanical characteristics:

Stem: It originated in the coastal area of Thailand. It is classified as a palm that sprouts from the underground stem or stems that slither on the ground poking the petioles and leaves up above the soil. The stems are branched underground. It grows in clumps and many sprouts about 3 meters in height. It grows well in clay soils, high organic matter, waterlogging area, and sunlight.

Figure 106 Nipa palms.

Photo by Researcher. 2018.

Leaf: It is a compound leaf. It is about 5-6 cm wide and 90-120 cm long. The leaf plate is thick and the tip looks slender. The base of the leaves is wedge-shaped (looks like a coconut leaf) and it is an inverted gutter. The upper surface of the leaves has a dark green luster. The lower surface of the leaves has a soft color. The large leaf sheath is wrapped at the base of the tree. The newly broken petioles are reddish purple in color. For the base of the leaves, there are air bulbs to help support the leaves up like a lifeboat.

Flower: Flowers are yellow flowering in clusters, tightly clustered between the leaf sheaths. Round shape flower are separate sexes on the same plant. Inflorescences are held up and curved down. It is about 25-65 cm long and can bloom all year round.

Fruit: The fruits are together in a bouquet. There are a number of sub-effects in clusters called "heads from". It is oval (similar to the fruit, but without thorns), flat, and convex in the center. The fruit is smooth, brown with a width of about 3-10 cm and a length of about 6.5-7.5 cm. The fruit has a pointed ridge or 9-10 grooves, inside with white seeds. There is not much meat and can be eaten It has a taste similar to that of fresh cannabis. Inside the fruit are oval and contained white seeds.

Figure 107 Dry Nipa palms.
Photo by Researcher. 2018.

4.8.1 Nipa fruticana with chemical analysis.

Dry Nipa fruticana (ลูกจากแห้ง)		**Nipa fruticana Ash** (เถ้าลูกจาก)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	14.192
MgO	Magnesium Oxide	3.792
Al_2O_3	Aluminum Oxide	0.168
SiO_2	Silicon Oxide	2.574
P_2O_5	Phosphorus Penoxide	0.938
K_2O	Potassium Oxide	7.17
CaO	Calsium Oxide	0.721
MnO	Maganese Oxide	0.166
Fe_2O_3	Iron Oxide	0.02
CHO	Carbohydrate	70.26

Table 9 : Dry-Nipa fruticana and Nipa fruticana-Ash withChemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.8.2 Nipa fruticana ash glaze chart tests.

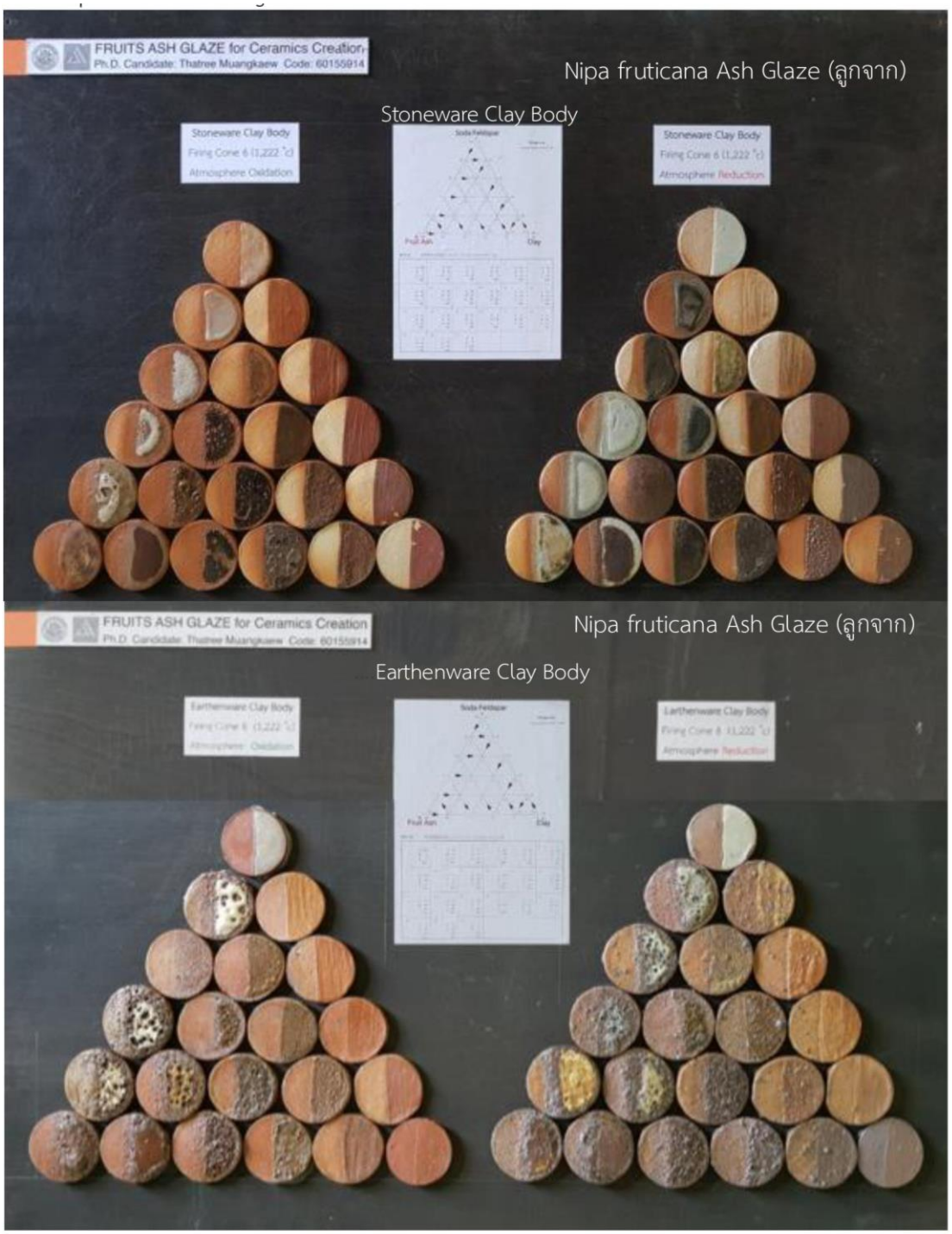


Figure 108 Triaxial blend glaze testing with Nipa fruticana Ash.

Photo by Researcher, 2019.

4.9 Peltophorum pterocarpum.

Scientific name**:** Peltophorum pterocarpum (DC.) Backer ex K. Heyne

Family name**:** Fabaceae

Common name**:** Copper pod, Yellow flame Tree and Yellow poincina.

Figure 109 Peltophorum pterocarpum.
Photo by Researcher, 2018.

Botanical characteristics:

Stem: The outer bark is grayish brown. The bark is smooth or fissuredl bark, the inner bark is pinkish brown. Young shoots appeared with reddish brown.

Leaf: The leaves are arranged alternately in bunches, circulating frequently. The leaves are composed of two feathers. Alternating dense at the ends of the branches. One bouquet is about 20-27 cm long, with leaves that are opposite each other in pairs, about 9-13 pairs, often the first pair is shorter than the next pair. And the pair at the end of the bouquet will be short as well. The appearance of the leaves is oblong. The tip of the leaf is rounded or slightly wavy. Rounded leaf under the margins are smooth. The leaves are about 0.5 cm wide and 1-1.5 cm long. The smooth leaves are dark green. The abdomen is smooth, light green.

Flower: a large bouquet is released by the leaf prongs or at the end of the branches. There are branches in the inflorescence of the inflorescence about 20-30 cm long and about 20 cm wide. The small flowers are bright yellow, the petals have **5** petals. The petals are thin and somewhat wrinkled. The base of the petal has sparse brown hairs. The flowers are 1.6-1.8 cm wide when fully bloomed, the sepals have **5** petals, the edges of the petals overlap. The flower has 10 stamens.

Pod and Fruit: The pods are flat and spear. The tip of the pod and the base of the pod are slender and pointed. It is about 2 cm wide and 5-12 cm long. The fresh pods are green when dry they will turn brown. There are about 1-4 seeds inside the pod arranged across the pod. The seeds are strong, shape and size as small as the leaves. The pods will mature in November.

Figure 112 Peltophorum pterocarpum fruit.Photo by Researcher, 2018.

4.9.1 Peltophorum pterocarpum chemical analysis.

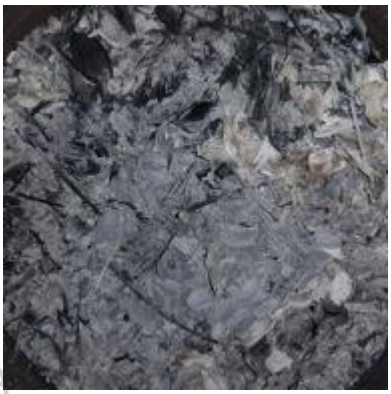
Dry Peltophorum pterocarpum (นนทรีแห้ง)		**Peltophorum pterocarpum Ash** (เถ้านนทรี)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	2.837
MgO	Magnesium Oxide	6.601
Al_2O_3	Aluminum Oxide	0.067
SiO_2	Silicon Oxide	0.263
P_2O_5	Phosphorus Penoxide	2.997
K_2O	Potassium Oxide	10.969
CaO	Calsium Oxide	11.669
MnO	Maganese Oxide	0.046
Fe_2O_3	Iron Oxide	0.058
CHO	Carbohydrate	64.493

Table 10 : Dry-Peltophorum pterocarpum and Peltophorum pterocarpum-ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.9.2 Peltophorum pterocarpum ash glaze chart tests.

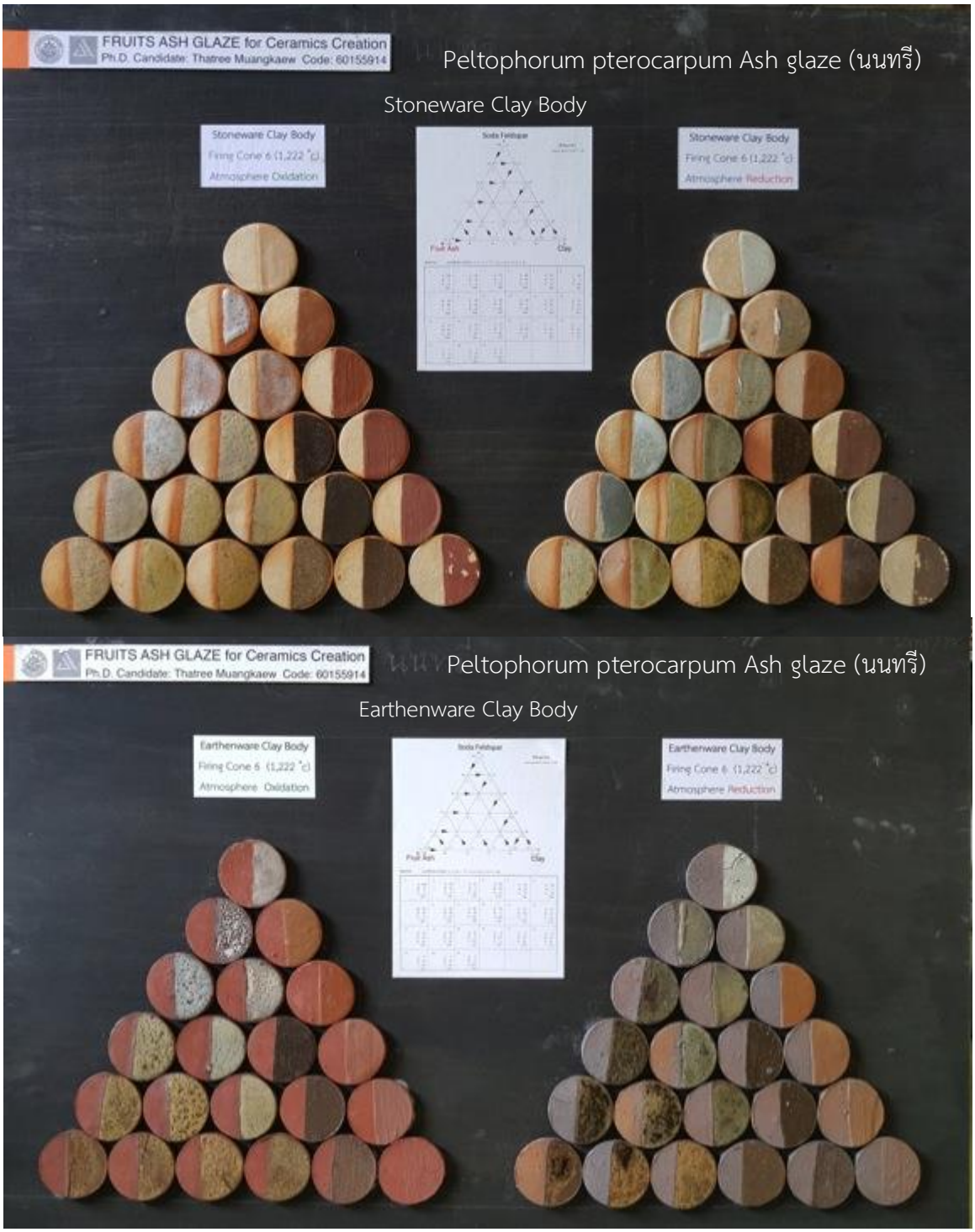


Figure 111 Triaxial blend glaze testing with Peltophorum Ash.

Photo by Researcher, 2019.

4.10 Shorea robusta.

Scientific name**:** Couroupita guianensis Aubl.

Family name**:** Lecythidaceae

Common name**:** Cannon-ball tree

Figure 112 Shorea robusta tree.

Photo by Researcher, 2018.

Botanical characteristics:

Stem: It has grayish brown, splinter and scaly bark.

Leaf: The single leaves alternately arranged. A cluster at the end of a branch Oblong to ovate-lanceolate, 5-8 cm wide, 12-25 cm long, pointed apex, base or rounded, shallow margins, thick leaves.

Flower: It is yellowish pink or red. The insider is light purple with a pink tint. Fragrant flowering bouquet is a large bouquet of flowers along the stem, inflorescence 30-150 cm long, the end of the bouquet is down, the petals are thick, 4-6 petals, the center of the flower is convex, the color is short, yellow, like a brush. Stamens are long lots of yellowish pink gradually bloom from the root to the end of the bouquet for a month, the flowers are in full bloom, 5-10 cm wide.

Figure 113 Shorea robusta drawing.
(Online) accessed on April 30, 2020, available from *https://th.wikipedia.org/wiki/%E0%B8%AA%E0%B8%B2%E0%B8%A5%E0%B8%B0#/media/ไฟล์:Shorea_robusta.jpg*

Pod and Fruit: It is dry with large sphere, 10-20 cm in size, hard shell, and reddish brown. Ripe fruit has foul smell, and many oval seeds.

Utilization: To planted as an ornamental plant in government offices, botanical gardens and arboretums because of its large beautiful and fragrant flowers.

Figure 114 Shorea robusta fruit.
Photo by Researcher, 2018.

4.10.1 Shorea robusta chemical analysis.

Dry Shorea robusta (ผลสาละแห้ง)		**Shorea robusta Ash** (เถ้าสาละ)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	2.039
MgO	Magnesium Oxide	1.83
Al_2O_3	Aluminum Oxide	0.453
SiO_2	Silicon Oxide	1.681
P_2O_5	Phosphorus Penoxide	2.058
K_2O	Potassium Oxide	16.533
CaO	Calsium Oxide	2.5
MnO	Maganese Oxide	0.01
Fe_2O_3	Iron Oxide	0.249
CHO	Carbohydrate	72.647

Table 11 : Dry-Shorea robusta and Shorea robusta-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.10.2 Shorea robusta ash glaze chart tests.

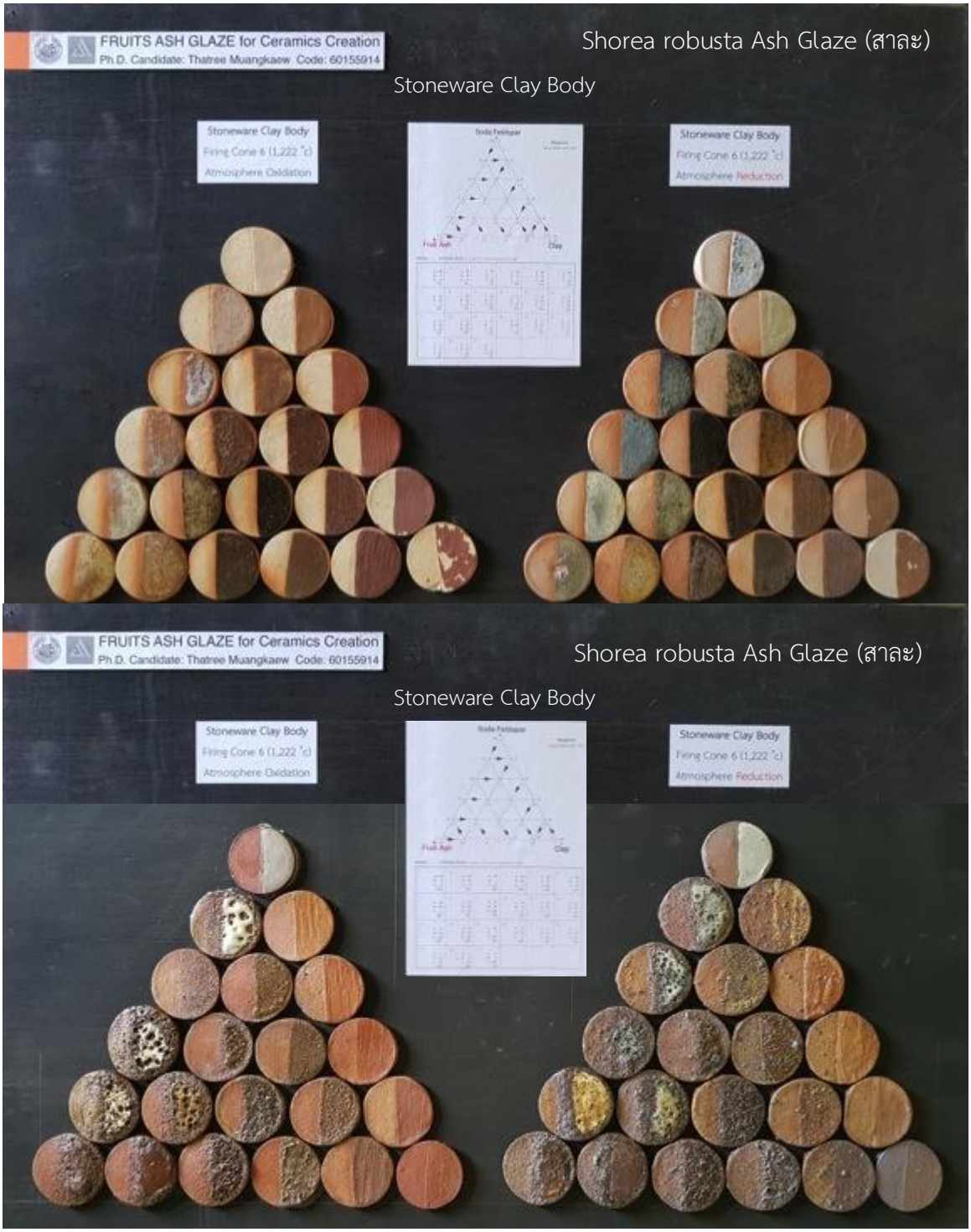


Figure 117 Triaxial blend glaze testing with Shorea robusta Ash. Photo by Researcher.

4.11 Sterculia foetida

Scientific name: Sterculia foetida L.

Family name: Sterculiaceae

Common name: Bastard poom, Pinari

Figure 118 Sterculia foetida tree. (Online) accessed on May 2, 2020, available from *https://www.gotoknow.org/posts/175525*

Figure 119 Sterculia foetida fruit. (Online) accessed on May 2, 2020, available from *https://medthai.com/%E0%B8%AA%E0%B8%B3%E0%B9%82%E0%B8%A3%E0%B8%87/*

Botanical characteristics:

Stem: A large tree, up to 30 meters tall, deciduous or oval to cylindrical tops, straight stems, and low lobule bases. The bark is smooth, grayish brown.

Leaf: It is a composite of a finger which spread out from the same point and arranged at the end of the branches. 5-7 leaves elliptic or oblong-elliptic 3.5-6 cm wide, 10-30 cm long, pointed apex or pointed lobe, base wedge-shaped, thick leaf plate, glabrous on leaves. 17-21 leaf veins on each side; petiole 13-20 cm long; petiole 3-5 mm long.

Flower: Red or bright inflorescence has very bad smell. It has 10-30 cm long, sepals 5 petals, apex curled, and 2-2.5 cm wide petals in full bloom. It is dry and kidney. The bark is hard like wood. It has red-brown, oily and smooth skin when old it splits into 2 halves. Width 6-9 cm. Length 8-10 cm., glossy black seeds, oblong shape, width 1.3 cm. Length 2.5 cm. Flowering period is during November-December. In Thailand, it is distributed in mixed deciduous and dry evergreen forests at an altitude of 10 to 600 meters above sea level.

Utilization: To use the pods to heal wounds in the stomach. Seeds are laxative, wound healing, bark dissolves phlegm. Wood is used to make furniture, plywood, bark is used to make rope. The seed oil is used for cooking and for starting fires.

Figure 120 Sterculia foetida dry fruit. Photo by Researcher, 2018.

4.11.1 Sterculia foetida with chemical analysis.

Dry Sterculia foetida (ผลสำโรง)		**Sterculia foetida Ash** (เถ้าสำโรง)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	1.235
MgO	Magnesium Oxide	1.762
Al_2O_3	Aluminum Oxide	0.758
SiO_2	Silicon Oxide	1.896
P_2O_5	Phosphorus Penoxide	1.136
K_2O	Potassium Oxide	16.886
CaO	Calsium Oxide	2.137
MnO	Maganese Oxide	0.003
Fe_2O_3	Iron Oxide	0.101
CHO	Carbohydrate	74.086

Table 12 : Dry-Sterculia foetida and Sterculia foetida-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.11.2 Sterculia foetida ash glaze chart tests.

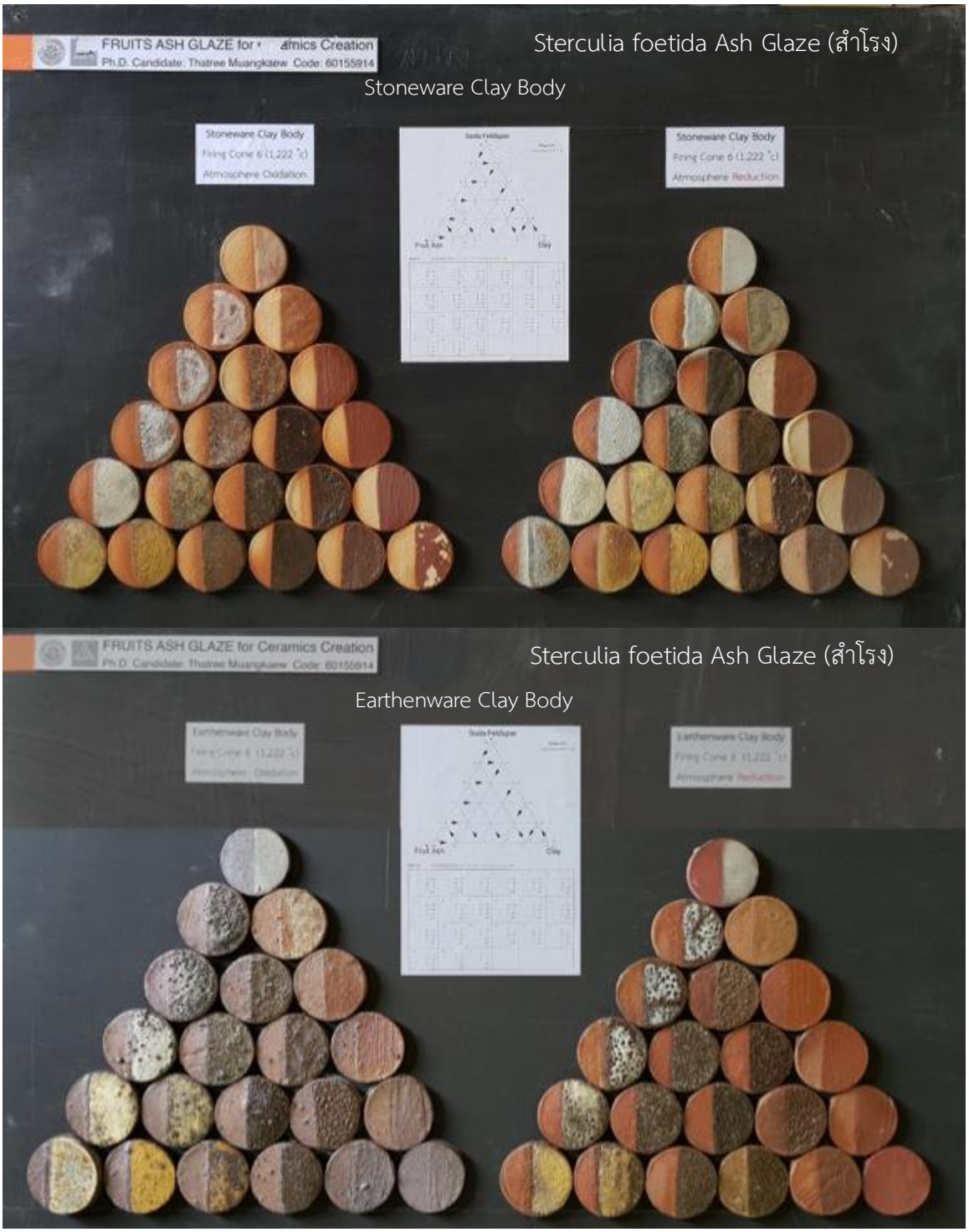


Figure 119 Triaxial blend glaze testing with Sterculia foetida Ash.

Photo by Researcher.

4.12 Terminalia catappa L.

Family name**:** CombretaceaeGenus: Termonalia

Species: T.catappa

Common name**:** Tropical almond, India almond

Scientific name**:** Terminalia catappa L.

Figure 120 Terminalia catappa tree.
(Online) accessed on May 4, 2020, available from https://id.wikipedia.org/wiki/Berkas:Terminalia_catappa_Blanco1.144.jpg

Botanical characteristics:

Stem: It is a medium to large perennial plant that have an erect stem. Branches are stratified horizontally. The canopy is quite round or densely pyramidal. The bark is gray and broken into shallow grooves and peel off into small flakes.

Leaf: The leaves are classified as single leaves. It has a light green color when the new leaves are budding. When old it turns yellow to brown, the leaves are arranged alternately at the ends of the branches. It is obovate, about 8-15 cm wide, 12-15 cm. long, with a pointed lobe at the end of the leaf. The base of the leaves is narrow, concave, and has 1 pair of glands. The leaf plate is thick and covered with soft hairs. The margins are smooth. It is deciduous in winter during October – November.

Flower: The flowers of the India almond are inflorescences in the axillary area or at the end of the branches. Small white flowers, composed of a base of sepals connected together. The tip is divided into 5 lobes, triangular in shape. Inflorescences are rod-shaped, about 8-12 cm long, flowers are white, no petals, male flowers are at the end of the bouquet. The flowers are perfect sex at the base of the bouquet. Flowering will be during February - April and August - October.

Fruit: The fruit is oval, fortified, and slightly flat. Width about 2-5 centimeters, length about 3-7 centimeters, with a green peel color. When it is mature, it is yellowish brown. When it dries, it will be dark black. When the flesh is peeled off or decomposed, it will be seen as fibers concentrated tightly around the fruit. It will consist of only 1 seed elongated oval shape. Its fruit is eatable and fragrant.

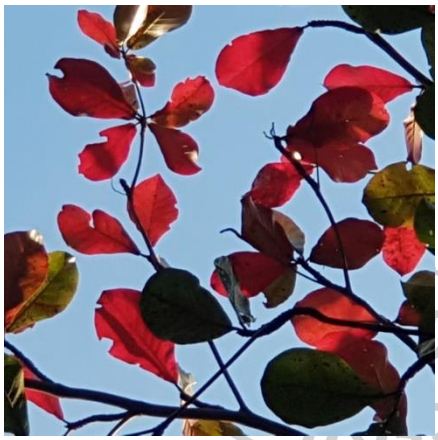


Figure 123 Terminalia catappa L. leaves. Photo by Researcher, 2018.

Figure 124 Terminalia catappa L. dry fruit. Photo by Researcher, 2018.

4.12.1 Terminalia catappa chemical analysis.

Dry Terminalia catappa (หูกวาง)		**Terminalia catappa Ash** (เถ้าหูกวาง)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	3.176
MgO	Magnesium Oxide	1.58
Al_2O_3	Aluminum Oxide	1.184
SiO_2	Silicon Oxide	3.295
P_2O_5	Phosphorus Penoxide	1.685
K_2O	Potassium Oxide	6.947
CaO	Calsium Oxide	2.978
MnO	Maganese Oxide	0.02
Fe_2O_3	Iron Oxide	0.285
CHO	Carbohydrate	78.851

Table 13 : Dry-Terminalia catappa L. and Terminalia catappa L.-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.12.2 Terminalia catappa ash glaze chart tests.

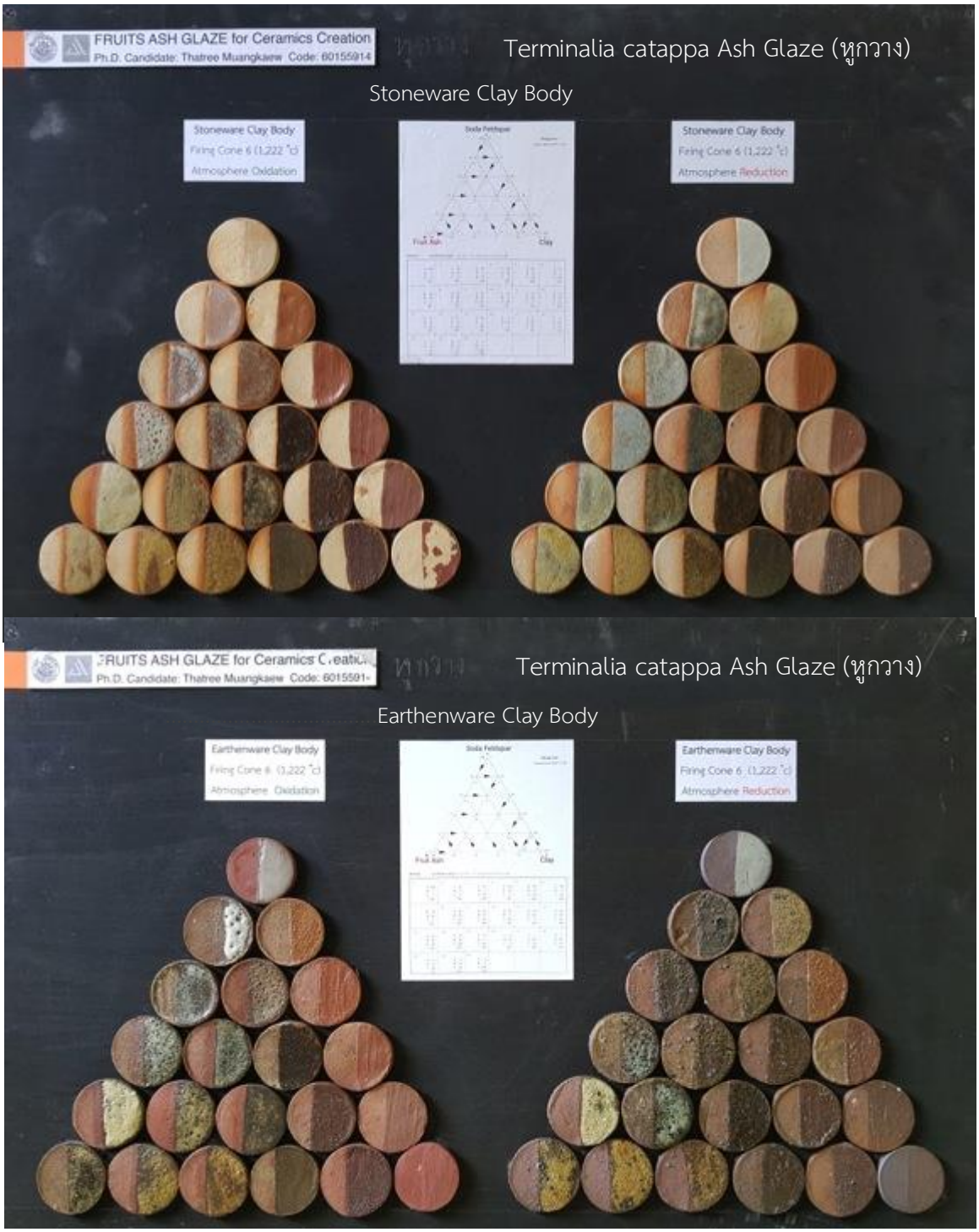


Figure 123 Triaxial blend glaze testing with Terminalia catappa L. Ash.

4.13 Xylia xylocarpa.

Scientific name: Xylia xylocarpa (Roxb.) Taub., Acacia Xylia xylocarpa (Roxb.) Willd., Inga Xylia xylocarpa (Roxb.) DC., Mimosa Xylia xylocarpa Roxb., Xylia dolabriformis Benth.

Family name: Leguminosae-Mimosoideae

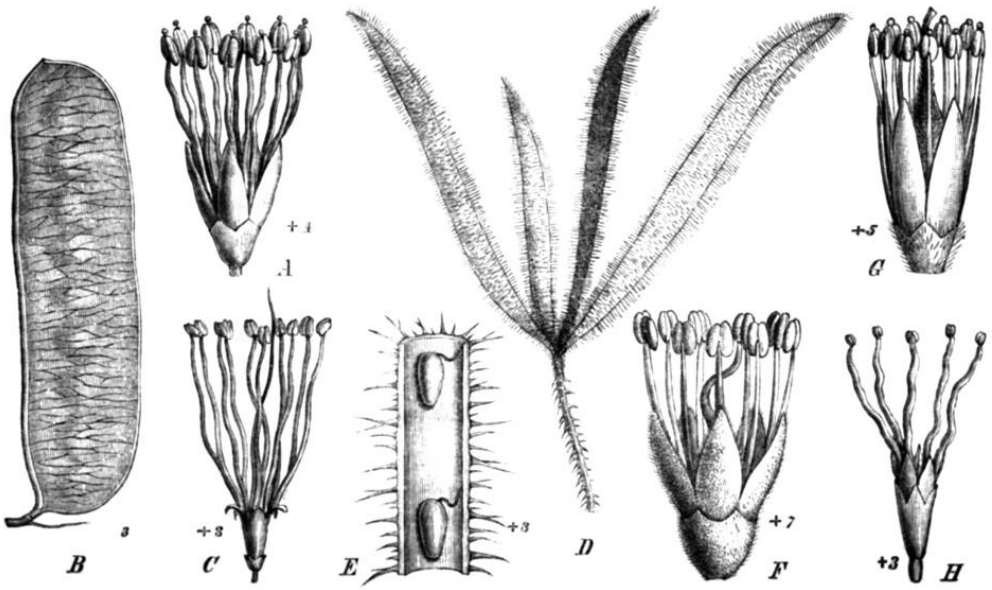


Fig. 72. *A* Bl., *B* Hülse von *Elephantorrhiza Burchellii* Benth. — *C* Bl., *D* Hülse, *E* Stück derselben von *Schranckia uncinata* Willd. — *F* Bl. von *Piptadenia contorta* Benth. — *G* Bl. von *Plathymenia reticulata* Benth. — *H* Bl. von *Xylia xylocarpa* (Roxb.) Taub.. Bei *C*, *F* und *H* Antherendrüsen abgefallen. (Original.)

Figure 124 Xylia xylocarpa inflorescence on the lower right.

(On line) accessed on May 7, 2020, available from

https://en.wikipedia.org/wiki/Xylia_xylocarpa#/media/File:Mimosoideae_spp_Taub72.png

Botanical characteristics:

Stem: It is a deciduous tree, medium to large size, 15-30 meters tall. Its stem is slender with descend branches. The bark is smooth, reddish-gray. The inner bark is pink when it is old. The bark is very cracked at the base of the tree. Young buds are sparsely or almost completely covered with light brown hair.

Leaf: Leaves are composed of double-feathered tips, spirally arranged. Petiole cylindrical, 4-7.5 cm long, sparsely pubescent to dense, glandular at the junction of the peduncle. Sub-leaves, auricle-shaped, yarn-shaped, about 3 mm long, 1 pair of sub- panicles, 10-30 cm long, the core is longitudinally grooved have short, fluffy fur or almost clean Gland between the petioles, leaves 3-6 pairs, opposite arrangement, oval to oval, 1.8-6.5 cm wide, 3.5-12.5 cm long, pointed or thorny, rounded or rounded, smooth edge, smooth top surface. The underside has sparse to velvet fur. It has 5-10 leaf veins per side, and 2-3 mm petiole. Young leaves emerge from March to April after flowering.

Figure 125 Xylia xylocarpa tree.
(On line) accessed on May 7, 2020, available from *https://www.dreamstime.com/tree-xylia-xylocarpa-roxb-taub-isolated-white-background-tree-xylia-xylocarpa-roxb-taub-isolated-white-background-image115769500*

Inflorescence: It is a globular with non-branched bunch, light yellow flowers arranged on a peduncle, and 1.5-2 cm. bases connected at the peduncle. At the end of the branches, peduncle 2.5-10 cm. long, consisting of many non-stemmed flowers. Ornamental leaves, spoon-shaped, 2-3 mm. long, sepals 3-3.5 mm. long, base conical, apex divided into 5 lobes, ovate to triangular with pointed tip. Outer surface

short, thick, velvety; petals 5 petals, 3.5-4.5 mm. long; base tubular, 5 lobed, narrowly oblong, pointed; outer surface, sparsely pubescent to densely pubescent, 10 stamens. Separated independently, 5-12 mm. long. Anthers without glands. Ovary above the lobe, 2-2.5 mm long, oblong-shaped, densely pubescent.

Fruit: It is a flat, kidney-shaped sheath, thick and hard, descending at the base, bent at the tip. Shaped like a boomerang, reddish brown, 3.5-6 cm. long, 9.5-10.5 cm. peduncle, smooth, hard, old pod split from tip to base. Split open into 2 halves. The wall of the split pod is often curled, twisted, 7-10 seeds, flat oval, about 7 mm wide, about 1 cm long, found in deciduous, mixed and dry evergreen forests. Height from near sea level to about 850 meters Flowering season is during February - March. Fruiting season is during November - January.

Utilization: To use as medicine for a fever, heart tonic, bark, astringent taste, helps to heal the elements, purify and nourish the blood. The bark is mixed with other herbs to cure thrush (skin symptoms, itchy rash, granules that look like prickly heat). very itchy and often accompanied by fever) Core, tart taste enter the drug to cure blood wasting disease (Cancer of the uterus and ovaries in women or men's lung cancer) purify and nourish the blood Cure blood wasting The essence is boiled drinking water as a laxative. Bark or pith, bruised, hemorrhage, seed pulp of young pods and young shoots, edible. Seeds of mature or dried pods are roasted. Or burn the fire until it is cooked and eaten. It tastes like watermelon seeds. Local people like to grate the red bark for cooking. The fruits and seeds are ground up and wrapped in cloth. Then bring to compress the pain, bruises, bark, bring to boil to cure the blood, heal the intestines, and cure diabetes.

Figure 126 Xylia xylocarpa dry fruit.
Photo by Researcher, 2019.

4.13.1 Xylia xylocarpa with chemical analysis.

Dry Xylia xylocarpa (ไม้แดง)		**Xylia xylocarpa Ash** (เถ้าผลไม้แดง)
		
Concentration		**(% w/w)**
Na_2O	Sodium Oxxide	1.444
MgO	Magnesium Oxide	2.137
Al_2O_3	Aluminum Oxide	0.223
SiO_2	Silicon Oxide	1.443
P_2O_5	Phosphorus Penoxide	1.823
K_2O	Potassium Oxide	12.212
CaO	Calsium Oxide	4.181
MnO	Maganese Oxide	0.094
Fe_2O_3	Iron Oxide	0.065
CHO	Carbohydrate	76.378

Table 14 : Dry-Xylia xylocarpa and Xylia xylocarpa-Ash with Chemical Analysis

by Assistant Professor SUPAKIJ SUTTIRUENGWONG, Ph.D.

Department of Materials Science and Engineering,

Faculty of Engineering and Industrial Technology, Silpakorn University.

Photo by Researcher, 2019.

4.13.2 Xylia xylocarpa ash glaze chart tests.

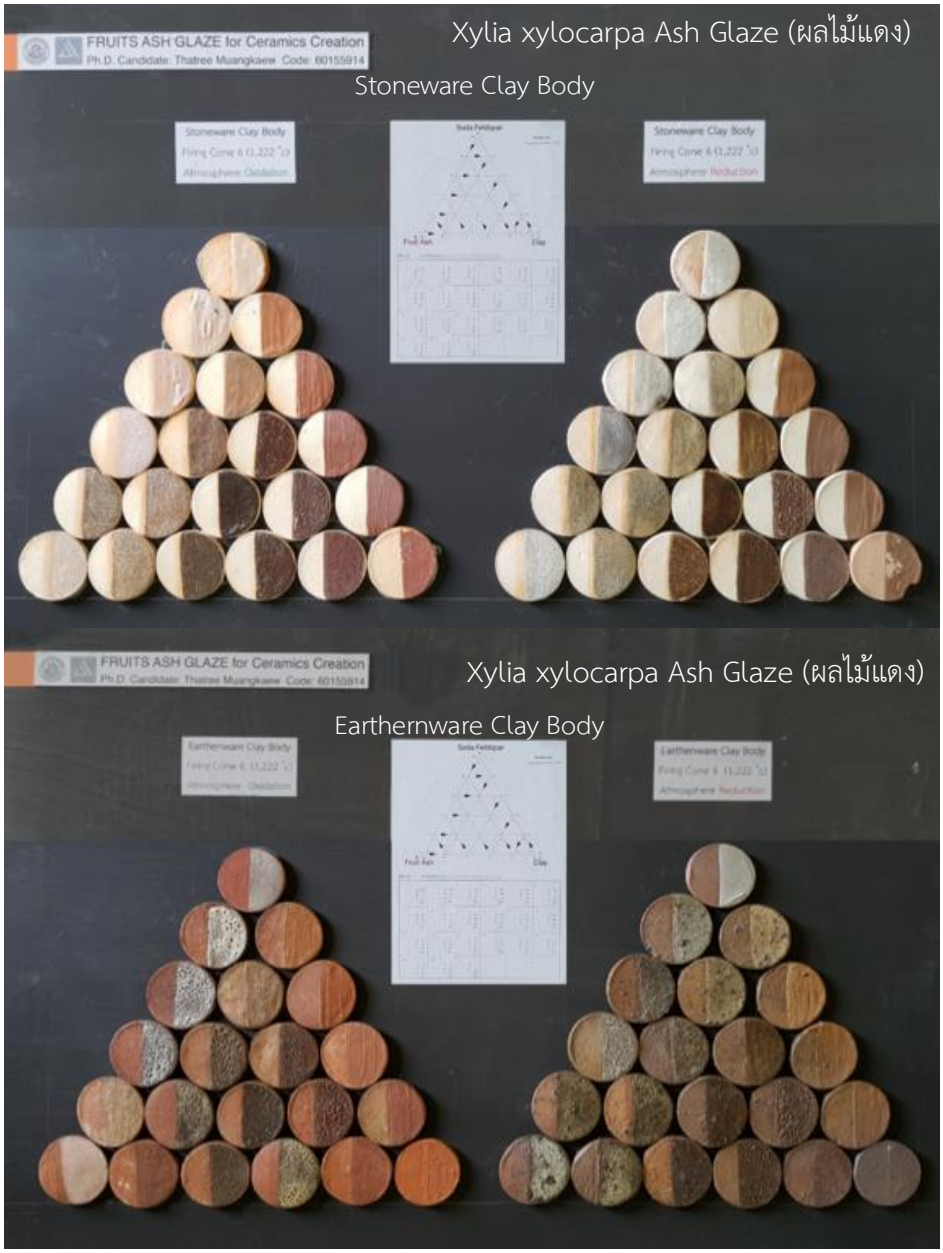


Figure 127 Triaxial blend glaze testing with Xylia xylocarpa Ash .

Photo by Researcher, 2019.

Chapter 5

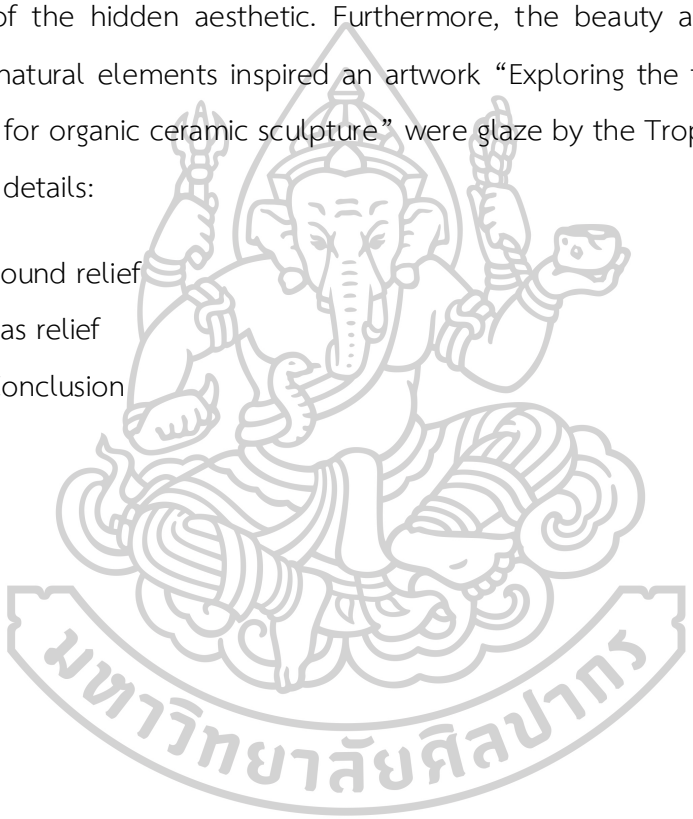
ORGANIC CERAMIC SCULPTURE WITH TROPICAL FRUITS ASH GLAZE

This chapter researcher created organic forms of ceramic sculpture by applying the fruits ash glaze as the case study. The fundamental form such as organic ceramic sculpture in round relief and bas relief by inspiration from natural forms such as plants and tree leaves were developed to be art forms for an expression of the hidden aesthetic. Furthermore, the beauty and aesthetic which came from natural elements inspired an artwork “Exploring the tropical fruits waste as ash glaze for organic ceramic sculpture” were glaze by the Tropical fruits ash glaze as following details:

5.1 Round relief

5.2 Bas relief

5.3 Conclusion



5.1 Round relief

In round relief researcher got inspiration from nature form are realistic representations of living things such as plants, Creating nature forms originate from the imitation of whole part of organic forms. However, some nature forms are designed by subtracting, or expansion a portion of original forms which distinctly result in emotions in created works.

5.1.1 Nature Form

As a case study of nature form creation, the researcher has got inspiration in creating works from the top portion of plants. These forms express the natural plant growth by making a simpler subtractive and addictive forms. Smooth and rough textures present the elegance of glaze coating the artworks.

The inspirations for creating artworks.

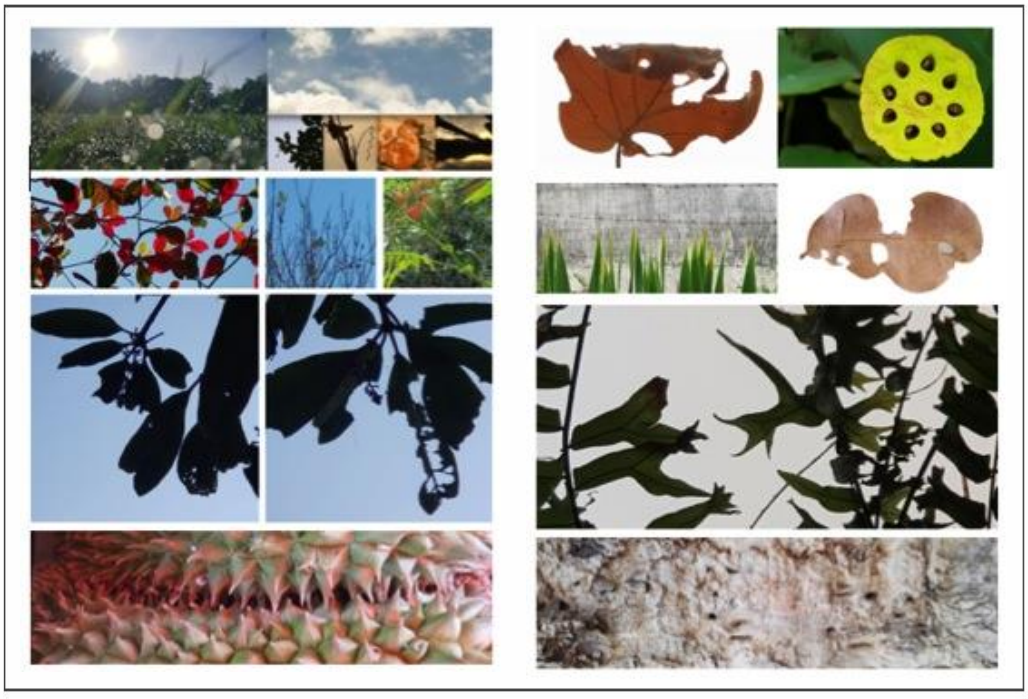


Figure 130 The inspirations for creating artworks. Photos by Researcher, 2019.

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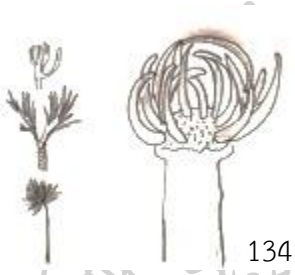
134

Figure 131 - 133 Images of plant tops which are the inspirations of form creation Photo by researcher, 2019.

Figure 132 Sketches of the artwork inspired by nature forms.

Drawing by researcher, 2019

Figure 133 The achieved artwork inspired by the plant tops stoneware clay body glazing with the durian rind ash glaze.

Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 136 - 137 Researcher improve art works with

Advisor Assoc. Prof. Sone Simatrang. Photo by Amelia Jay, 2019.

Figure 136 An image of dried lotus which is the origin of form creation.

Photo by researcher, 2019.

Figure 137 The top of lotus artwork coated by the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.

Photo by researcher, 2019.

Figure 138 The created lotus artwork earthenware clay body glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.

Photo by researcher, 2019.

5.1.2 Free form

Free form are also known as irregular forms. These are erratic forms depending on the environmental influences and the creator desires. In addition, they generate the emotion of non-stop mobility.

In this free form case study, the researcher created a form which influenced from the structural direction and angle transformation of form. It shows that the glaze can be applied on the sloping direction of the ceramic surface.

Figure 141 An image of Northern Black Wattel sheath which is the origin of form creation. Photo by researcher, 2019.

Figure 140 Pencil sketches of an artwork studied from Northern Black Wattel sheath. Drawing by researcher, 2019.

Figure 143 The achieved artwork, “Message from the universe” stoneware clay body glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 142 Structure of Frangipani Tree, Inspiration for creation ceramic form. Photo by researcher, 2019.

Figure 145 The achieved artwork., “Message from the universe” stoneware clay body glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

5.1.3 Pure form

Pure form does not represent anything. This type of form derived from the subtraction and addition of nature form until the trace of original form is totally vanished. A new form is possibly created without references of nature however it is the integration of geometric forms. Pure forms emphasize on idea more than emotion.

In case study of developing artworks in pure form, the researcher presented an artwork in the form of sculpture that was inspired by top portion of plants. Researcher was interested in forms with various features that were unique and beautiful.

Figure 146 – 151 Images of plant tops which are the inspirations of form creation. Photos by researcher, 2019.

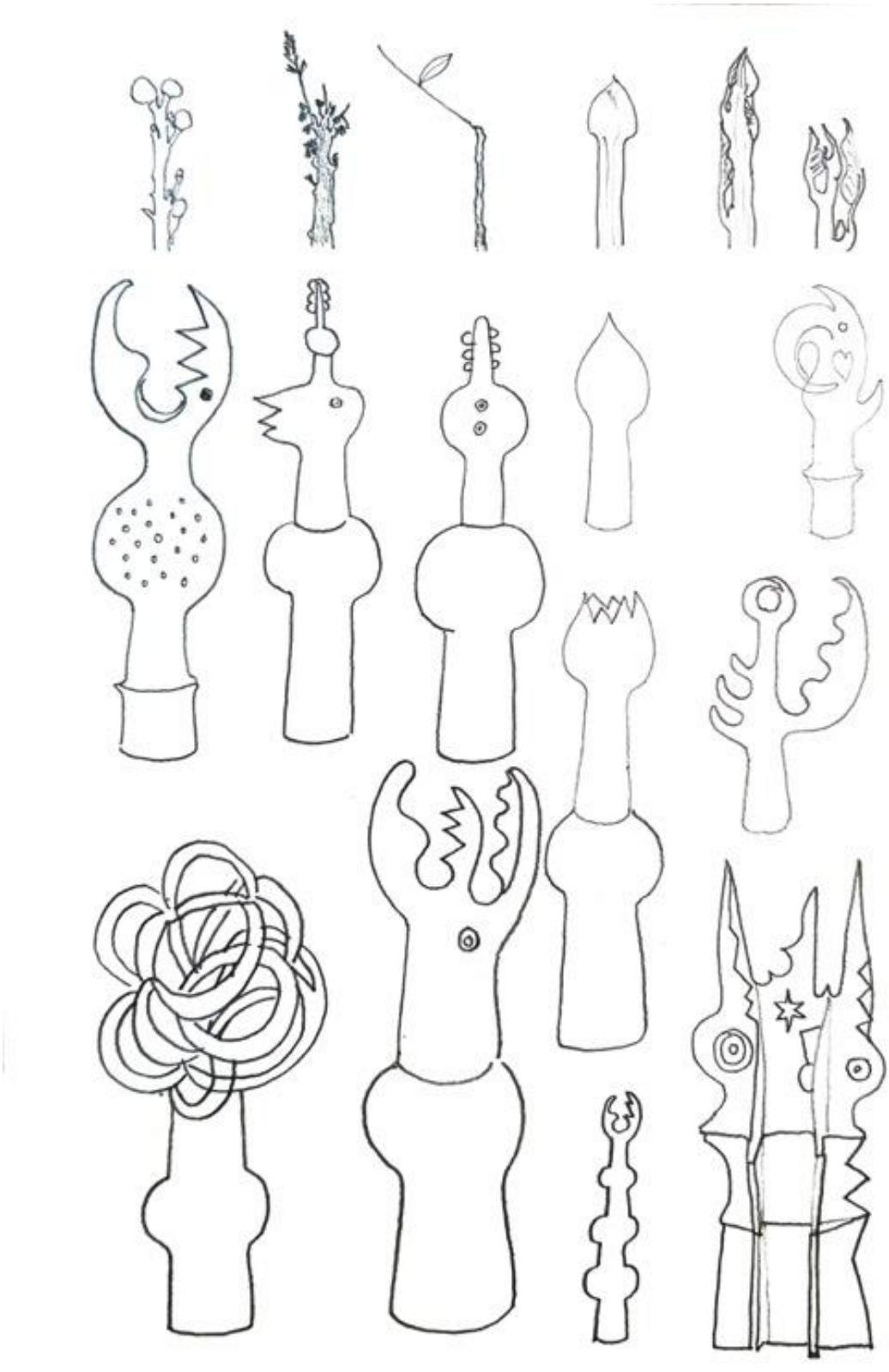

Figure 150 Pencil sketches of the artwork.

Drawing by researcher, 2019.

Figure 153 An image of morning glory which is the origin of form creation. Photo by researcher, 2019.

Figure 154 – 155 Pencil sketches of the artwork originated by morning glory. Drawing by researcher, 2019.

Figure 156 The researcher was forming artwork. Kanyarat Muangkaew, 2019.

Figure 157 The biscuit fired clay at 800 °c. Photo by researcher, 2019.

Figure 158 The researcher coated the durian rind ash glaze on artwork, 2019.

Figure 159 The gas kiln. Photo by researcher, 2019.

Figure 160 The achieved artwork, “Message from the universe” earthenware clay body glazing with the durian rind ash glaze. Firing at 1,222 ๐c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 161 The achieved artwork, “Message from the universe” earthenware clay body glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 162 The achieved artwork, “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 161 The achieved artwork.

“Message from the universe” earthenware clay body glazing with the Natural ash glaze. Firing at 1,230 ˚c by wood kiln.

Photo by researcher, 2019

Figure 164 The achieved artwork.,“Message from the universe” earthenware clay body glazing with the Delonix regia pod ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 165 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 166 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia pod ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 167 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia pod ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Photo by researcher, 2019.

Figure 168 - 169 The achieved artwork, “Message from the universe” earthenware clay body glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.Photo by researcher, 2019.

5.1.4 Conclusion round relief sculpture.

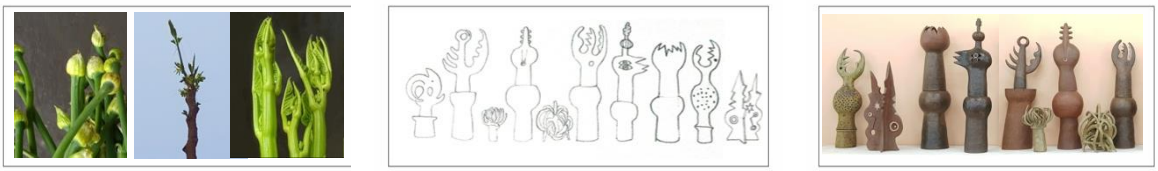

Figure 170 - 172 Inspiration, drawing and the organic ceramic sculpture (round relief) glazing with tropical fruit ash glaze. Photo and drawing by Researcher, 2020.

These organic ceramic sculpture art works were inspired from the top of morning glory. The researcher created these nature forms to express the growth of plants.

The originality of these sculptures can be showed through the nature forms. The growth of plant is the beauty that exists in the form because the identity of each kind of plants is the art form in nature. The researcher spent time around 24 months for creating ceramic sculpture pieces and tropical ash glaze test.

Figure 173 Dona i Ocell by Miro. (Online) Accessed on July 29, 2021. Available from *https://www.2luxury2.com/miro-spirit-flies-free-again-from-mallorca-vaults/dona-i-ocell-1982-barcelona-spain/*

This line expresses the feelings of plant growth. Artistic influence of Joan Miro's work was inspired from natural form and created as pure form. The researcher defined this form as the representative of plant growth. Its mass and shape can convey the spirit of growth.

5.2 Bas Relief

The researcher presented an artwork with a deep groove scraping on the workpiece and paint glaze in the scraped section in a case study of making an artwork in the shape of pure form by utilizing method of caving and paint glaze. Furthermore, the researcher removed portions of the specimen to emphasize the beauty of the unglazed on earth surface. Initially, the glaze and unglaze regions were produced. The researcher sought a balance between the two as a guideline for creating ceramic artwork in its purest form.

This series was inspired by the trees and grasses that surrounded the researcher. Things and empty spaces have always piqued the researcher's interest. The items discussed include trees, leaves, branches, or a mix of these elements that demonstrate their lovely form. The following examples of inspiring pictures contain all the inspirations to produce artworks:

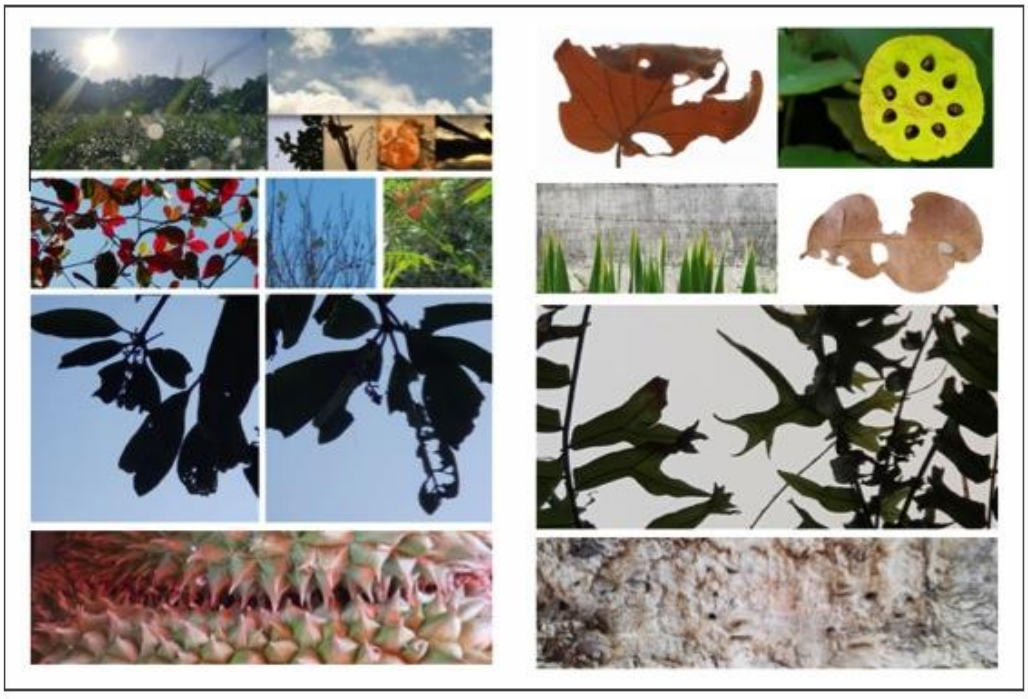

Figure 172 The inspirations for creating artworks.

Photos by Researcher, 2019.

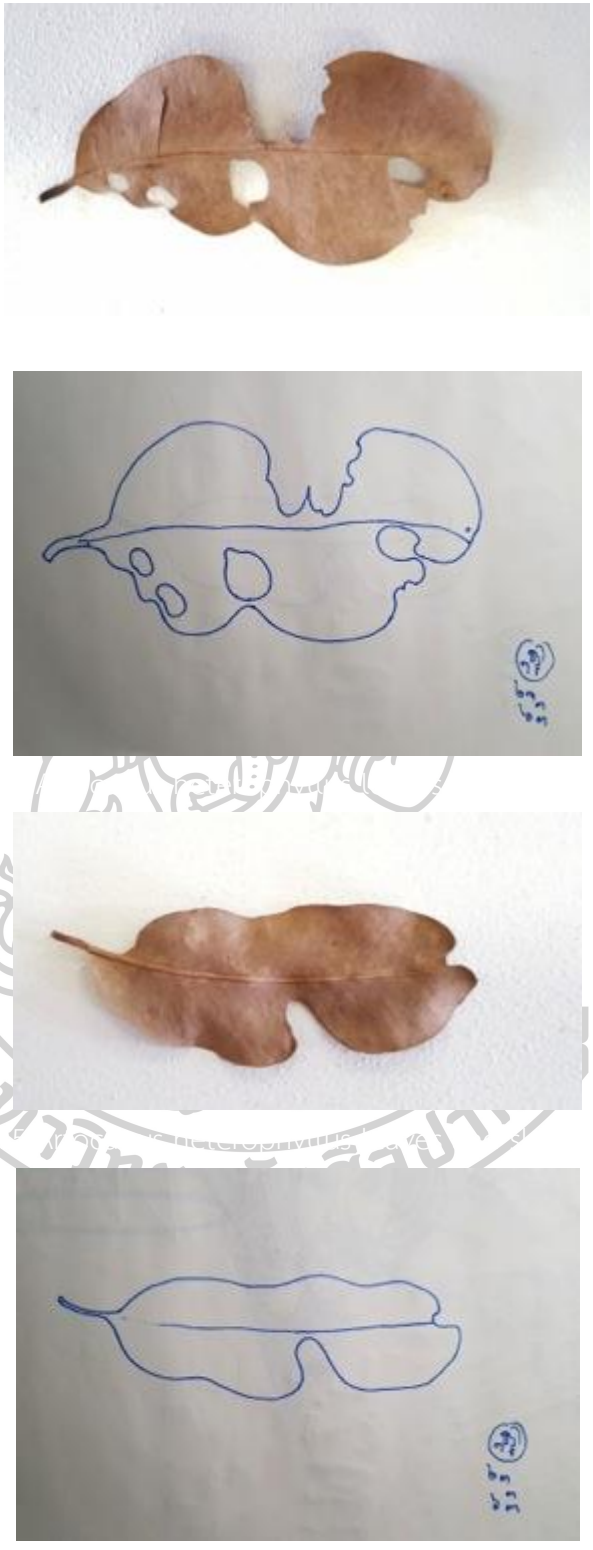

Figure 175 - 178 Artocapus heterophyllus leaves and sketches study by researcher, 2019.

Figure 177 Sketches pencil on paper

by researcher, 2020.

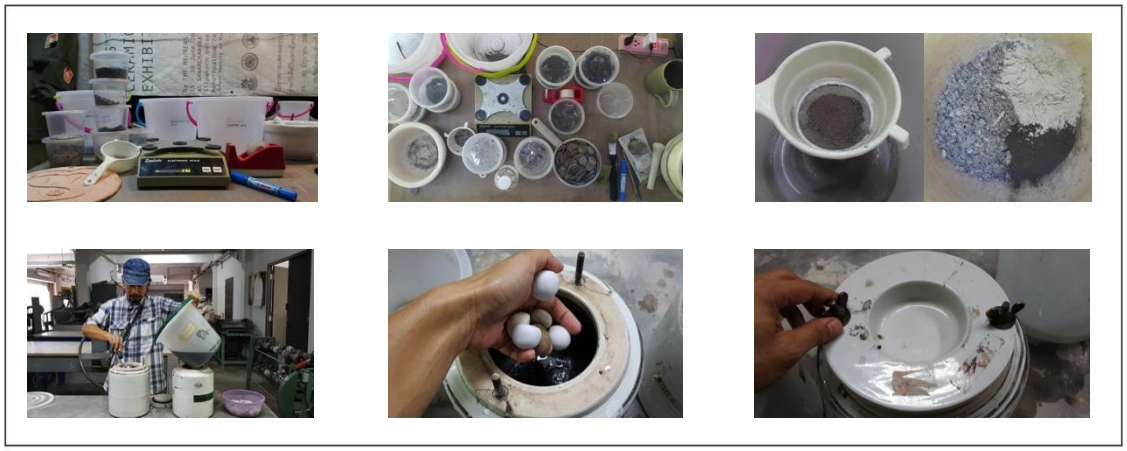

Figure 180 Mixed glaze process, weigth, mixed with soda feldspar and clay then put in ball mill. Photo by Suppasit Asavisanu, 2019.

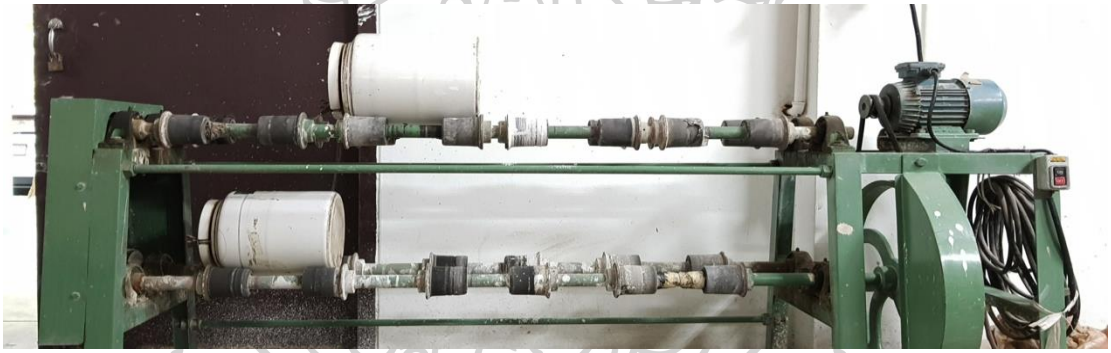

Figure 181 Mixed glaze process, put ball mill machine. Photo by Researcher, 2019.

Figure 182 – 183 Mixed glaze process, sieve glaze. Photo by Researcher. 2019.

Figure 184 Glaze after mixing. Photo by Researcher, 2019.

Figure 185 – 187 Paint glaze on ceramic work. Photo by Kanyarat Muangkaew, 2019.

Figure 188 Loading work. in to the kiln.

Figure 189 Gas Kiln at Department of Ceramic, Silpakorn University. Photo by Researcher, 2019.

Figure 190 Sketch pencil on paper by researcher.

Figure 191 Dry clay work before firing.

Figure 192 After firing 800°c and painted glaze.

Figure 193 The achieved artwork, “Message from the universe” stoneware clay body glazing with the corn ash glaze. Firing at 1,222 °c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 194 Sketch pencil on paper by researcher.

Figure 195 Dry clay work before firing.

Figure 196 After firing 800°c and painted glaze.

Figure 197 The achieved artwork, “Message from the universe” stoneware clay body glazing with the couroupita guianensis ash glaze. Firing at 1,222 °c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 198 Sketch pencil on paper by researcher.

Figure 199 Dry clay work before firing.

Figure 200 After firing 800˚c and painted glaze.

Figure 201 The achieved artwork, “Message from the universe” stoneware clay body glazing with the nypa fruticans ash glaze. Firing at 1,222 ˚c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 200 Sketch pencil on paper by researcher.

Figure 201 Dry clay work before firing.

Figure 202 After firing 800˚c and painted glaze.

Figure 205 The achieved artwork., “Message from the universe” stoneware clay body glazing with the coffee ash glaze. Firing at 1,222 ˚c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 204 Sketch pencil on paper by researcher.

Figure 205 Dry clay work before firing.

Figure 206 After firing 800˚c and painted glaze.

Figure 209 The achieved artwork., “Message from the universe” stoneware clay body glazing with the delonix regia ash glaze. Firing at 1,222 ˚c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 208 Sketch pencil on paper by researcher.

Figure 209 Dry clay work before firing.

Figure 210 After firing 800˚c and painted glaze.

Figure 213 The achieved artwork., “Message from the universe” stoneware clay body glazing with the sterculia foetida ash glaze. Firing at 1,222 ˚c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 212 Sketch pencil on paper by researcher.

Figure 213 Dry clay work before firing.

Figure 214 After firing 800˚c and painted glaze.

Figure 217 The achieved artwork., “Message from the universe” stoneware clay body glazing with the coffee ash glaze. Firing at 1,222 ˚c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 216 Sketch pencil on paper by researcher.

Figure 217 Dry clay work before firing.

Figure 218 After firing 800°c and painted glaze.

Figure 221 The achieved artwork., “Message from the universe” stoneware clay body glazing with the durian rind ash glaze. Firing at 1,222 °c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 221 Sketch pencil on paper by researcher.

Figure 222 Dry clay work before firing.

Figure 224 After firing 800°c and painted glaze.

Figure 225 The achieved artwork., “Message from the universe” stoneware clay body glazing with the pinus kesiya ash glaze. Firing at 1,222 °c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Figure 224 Sketch pencil on paper by researcher.

Figure 225 Dry clay work before firing.

Figure 226 After firing 800°c and painted glaze.

Figure 229 The achieved artwork., “Message from the universe” stoneware clay body glazing with the pinus kesiya ash glaze. Firing at 1,222 °c by gas kiln in reduction atmosphere. Photo by researcher, 2019.

Green ware earthenware clay body.

Figure 228 Greenware earthenware clay body.

Photos by researcher, 2020.

Earthenware clay body firing at 800 ˚c

Figure 229 Earthenware clay body firing at 800˚c.

Photos by researcher, 2020.

Figure 232 The achieved artwork.,“Message from the universe” earthenware clay body glazing with the Sterculia foetida (ผลสำโรง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 233 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ฝักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 234 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (มังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 235 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Sterculia foetida (ผลสำโรง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 236 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum (นนทรี) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 237 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Cassia fistula (ราชพฤกษ์) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 238 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Sterculia foetida (ผลสำโรง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 239 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 240 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum (นนทรี) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 241 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (ฝักหางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 242 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Terminalia catappa (ผลหูกวาง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 243 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (ฝักหางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 244 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum (นนทรี) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 245 The achieved artwork.,“Message from the universe” earthenware clay body glazing with the Terminalia catappa (ผลหูกวาง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 246 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 247 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum (นนทรี) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 248 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ฝักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 249 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Peltophorum pterocarpum (นนทรี) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 250 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Lagerstroemia floribunda (ผลตะแบกนา) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 251 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Shorea robusta (ผลกาละ) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 252 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Lagerstroemia Terminalia catappa (ผลหูกวาง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 253 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Cassia fistula (ราชพฤกษ์) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 254 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Shorea robusta (ผลสาละ) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 255 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ฝักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 256 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (ฝักหางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 257 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Shorea robusta (ผลสาละ) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 258 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 259 The achieved artwork. , “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 260 The achieved artwork. , “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ฝักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 261 The achieved artwork. . , “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 262 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ฝักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 263 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (ฝักหางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 264 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 265 The achieved artwork. ., “Message from the universe” earthenware clay body glazing with the Garcinia Nipa fruticana (จาก) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 266 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ผักไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 267 The achieved artwork ., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (ผลมังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 268 The achieved artwork. , “Message from the universe” earthenware clay body glazing with the Nipa fruticana (จาก) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm.
Photo by researcher, 2020.

Figure 269 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Shorea robusta (สาละ) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 270 The achieved artwork. , “Message from the universe” earthenware clay body glazing with the Nipa fruticana (จาก) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm.
Photo by researcher, 2020.

Figure 271 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Shorea robusta (สาละ) ash glaze. Firing at 1,222 ๐c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 272 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (มังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.

Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 273 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (หางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 274 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Sterculia foetida (ผลสำโรง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 275 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Terminalia catappa (หูกวาง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 276 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Terminalia catappa (หูกวาง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 277 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Lagerstroemia floribunda (ตะแบกนา) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.
Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 278 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Delonix regia (หางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.
Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 279 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Sterculia foetida (สำโรง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.
Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 280 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Nipa fruticana (จาก) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.
Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 281 The achieved artwork**.** , “Message from the universe” earthenware clay body glazing with the Delonix regia (หางนกยูงฝรั่ง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere.
Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 282 The achieved artwork , “Message from the universe” earthenware clay body glazing with the Xylia xylocarpa (ไม้แดง) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

Figure 283 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Garcinia mangostana linn (มังคุด) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Diameter 30 cm. Photo by researcher, 2020.

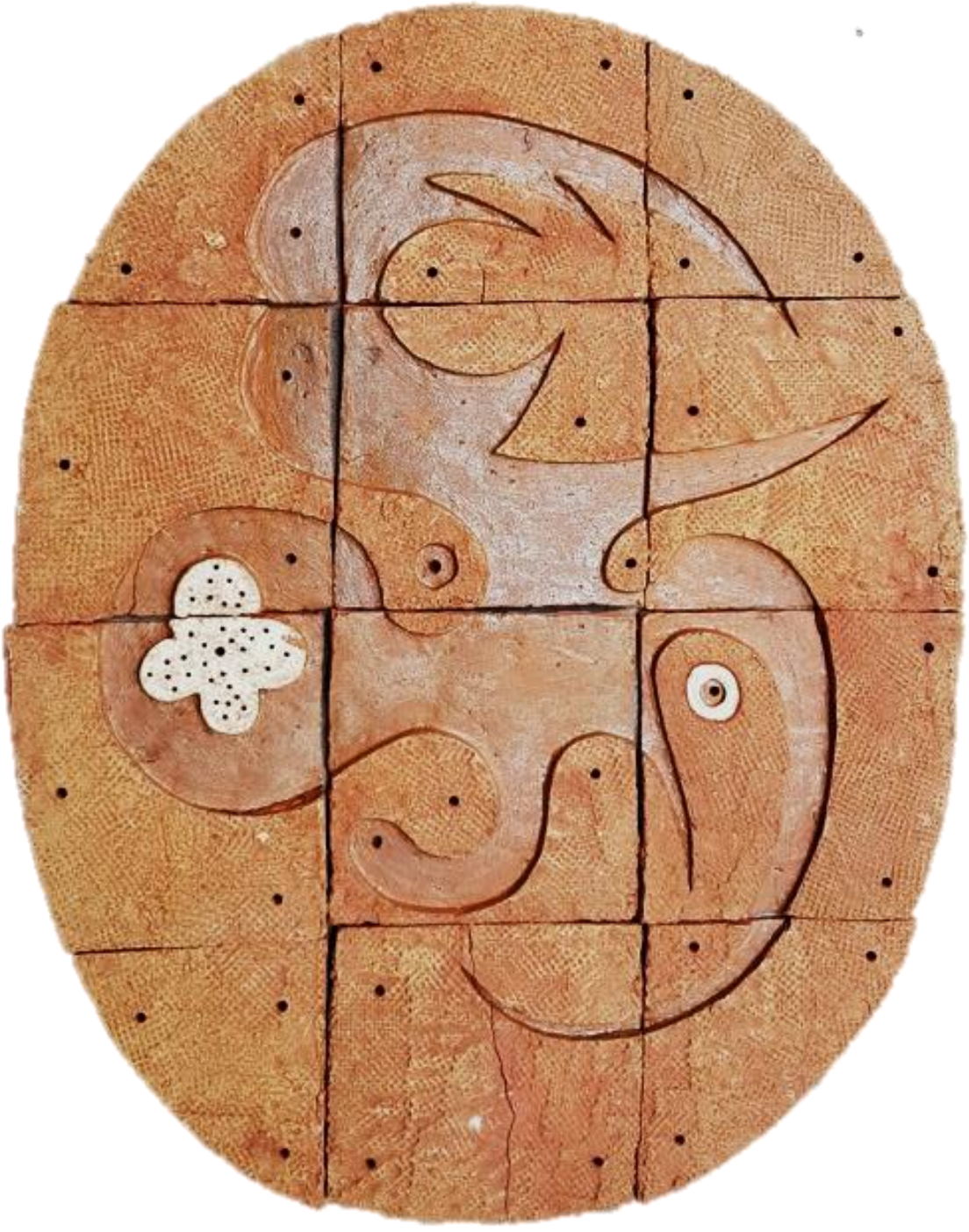

Figure 284 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Cassia fistula (ราชพฤกษ์) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Size 90 X 120 cm. Photo by researcher, 2020.

Figure 285 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Durio (ทุเรียน) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Size 90 X 180 cm.
Photo by researcher, 2020

Figure 286 The achieved artwork., “Message from the universe” earthenware clay body glazing with the Durio (ทุเรียน) ash glaze. Firing at 1,222 ˚c by electric kiln in oxidation atmosphere. Technique carving on slab. Size 90 X 120 cm.
Photo by researcher, 2020.

5.3.1 Conclusion bas relief sculpture.

Figure 285 The development of bas relief works.
Photo and drawing by Researcher, 2020.

These organic ceramic sculpture art works were inspired from leaf shapes and space to create forms and express move and balance.

The originality of these sculptures can be showed through nature forms. The move and balance of the plant shapes is the beauty that exists in the form because the identity of each kind of plants is the art form in nature. The researcher spent time around 24 months for creating ceramic sculpture pieces and tropical ash glaze test

Figure 286 Relief Clock by Jean (Hans) Arp, 1914
(Online) Accessed on July 29, 2021. Available from *https://letstalkdada.wordpress.com/2012/04/25/jean-hans-arp/*

This line expresses the feelings of move and balance. Artistic influence of Jean (Hans) Arp's works are usually abstract; nevertheless, they were identified clearly with natural forms. The researcher defines this form as the representative of move and balance. Its space and shape can convey the spirit of move and balance.

5.3 Conclusion

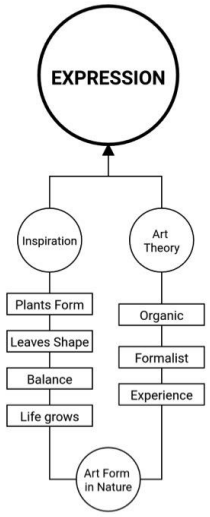

Figure 287 Conclusion of expression flowchart.

The body of knowledge obtained the study technique to express various experiment of the tropical fruits ash glaze by using kiln technique in oxidation and reduction. Besides, there are the ceramic creation processes which use round relief and bas relief to show the beauty of organic ceramic sculptures coated with tropical fruits ash glaze.

The most appropriate material to make the special desired appearance of this series is the glaze which made from waste. The glaze can increase value and charm on the surface of the art works, so the ceramic sculptures will be durable and remain beautiful for a thousand year.

The art works in the series entitled "Message from Universe" had been accomplished the tropical fruits ash and proved to be the good material for glazing on organic ceramic forms as follows:

4.3.1 To transform natural raw material such as waste into the component of ceramic creation.

4.3.2 The surfaces of art works show the identity of earth tone color.

4.3.3 The organic ceramic sculptures coated with tropical fruit ash glaze express the spirit of natural growth, move, and balance.

Chapter 6

Conclusion of the research

The researcher became aware of the problem of fruit waste as a result of the large volume of fruit consumed and the difficulty in disposing of trash. According to the survey, there was a significant amount of durian rind trash that polluted the environment and had an impact on society. There are some plant species, as well as fruit waste or dried fruit that has fallen to the ground, generate disposal or decomposition issues. Therefore, the researcher wanted to import trash from durians and other tropical fruits to experiment with ash glazing. To investigate the potential of tropical fruits waste ash glaze, the researcher examined the history of ash glaze and glazing technologies from Asia, including China, Korea, Japan, and Thailand. Furthermore, the artworks were made by the researcher employing tropical fruits waste ash glaze for the organic ceramic sculpture.

The research results of 13 ash samples and 800 study experiments were acceptable. Tropical fruit ash glaze has also been used to create organic ceramic sculptures in round relief and bas relief. Based on experiments and a study of the literature, this research result is considered new skills and information that will lead to further developments in ceramic works, as summarized below:

6.1 Objective and result.

6.2 New knowledge from tropical fruits ash glaze.

6.3 Result of the organic ceramic sculpture with tropical fruits ash glaze.

6.4 Development in the future.

6.1 Objective and result.

6.1.1 To explore and experiment how to making ash glaze from tropical fruits waste.

The researcher successfully developed tropical fruit ash glaze with 13 ash samples and 800 study experiments were acceptable by utilizing Triaxial blend theory after researching history and knowledge in ash glaze manufacturing. The experiment's results were designed to make artworks with varying surfaces and colors depending on the aim of the work and expression.

Figure 290 Dried tropical fruits., Sukhotai pottery, nature and the organic ceramic sculpture (Bas relief). Photos by Researcher, 2021.

6.1.2 To create organic ceramic sculpture for case study about expression from the integrate of the organic ceramic sculptures with tropical fruits ash glaze.

The researcher is inspired to create artworks based on natural forms by studying and sketching plants in their nature. The researcher then created round relief designs to observe the development of vertical and dynamic patterns. There was also a bas relief form to demonstrate horizontal coating. The experiments with both forms were successful.

6.1.3 To justify the aesthetic of organic ceramic sculpture with tropical fruits ash glaze.

Some ceramic artists grasp the outstanding realistic manufacturing method, resulting in art pieces that appear to be made of genuine leather, silk, or vegetal. That is not the researcher's intention; The truth of the material is an aspect that the researcher intends to show. There is no uncertainty in the viewer's mind that the researcher's Message from Universe Series is made of clay. It has been correctly processed. Extensive testing allows the researcher to acquire the highest quality ash, which is then mixed with clay to create art work.

6.1.3.1 Texture

The researcher used the outcomes of the experiment to create a smooth coating which can be used to glaze food containers or decorative surfaces, as well as construct sculptures and aesthetic works. This is determined by the aim of the ceramic creation. The researcher applied it to the artwork in the case of a rough surface. Sculptures or other artworks that are not intended to be used as food containers, glaze with uneven surfaces, and texture may be utilized to make ceramic art since texture is one of the major components that generate an emotional receptive from the works of art.

Figure 289 Experiment with a variety of textures in case studies.

Photo by Researcher, 2019.

6.1.3.2 Color

Depending on the quantity of iron in the ash, the glaze will be warm yellow, light brown dark brown, or black in the oxidation atmosphere. Because iron is converted from a ferric to a ferrous state in the reduction fire environment, the glaze color is grey or grayishgreen, olivegreen, or bluish gray.

6.2 New knowledge from tropical fruits ash glaze.

There was a wide variety of coating in earth tone hues based on all of the results of the experiment based on Triaxial blend theory. The color of each glaze varies according on the amount of glaze and oxide in the glaze. The oxide in glaze is determined by the chemical composition, which is dependent on the ratio of ash, soda feldspar, and clay.

Figure **290** Knowlege data 880 Test pieces of Fruits Ash Glaze.
Photo by Researcher.

According to the survey, there was a considerable volume of durian rind waste that caused pollution and affected toward society. As a result, the researcher is interested in bringing waste from durians and other typical fruits in Thailand to experiment with ash glaze. Since it was used for several types of ceramics, the research findings can be utilized for ceramic creations, and will be the case study of making an own uncomplicated ceramic glaze.

6.3 Result of Exploring the tropical fruits waste as ash glaze for organic ceramic sculpture.

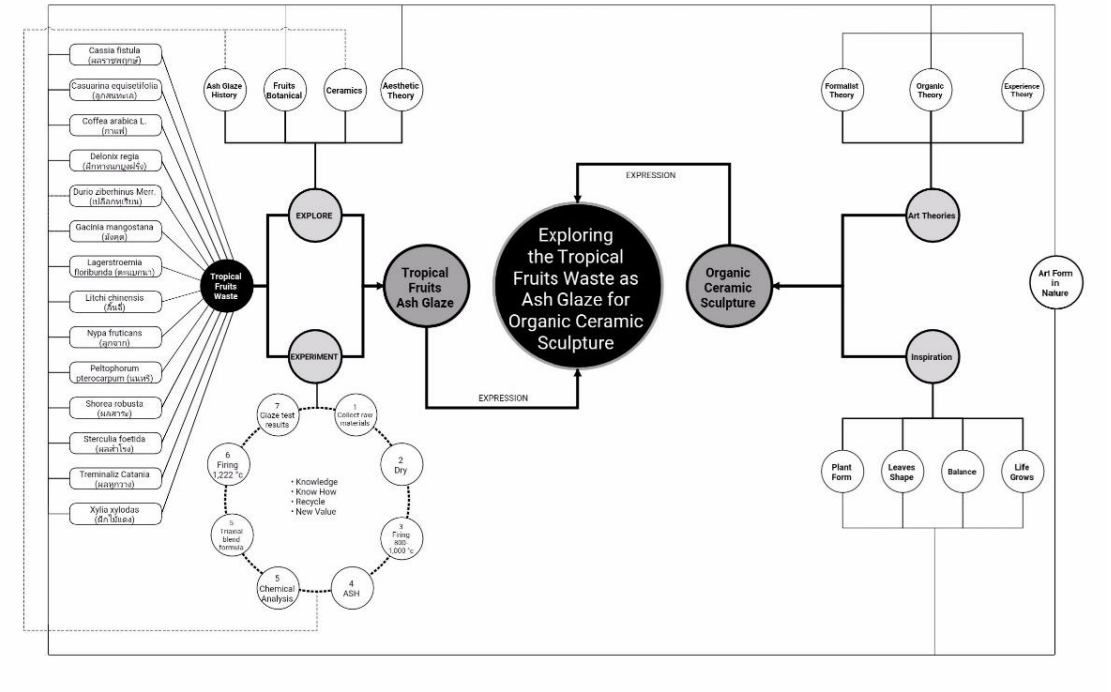

Figure 291 The flowchart shows the research conclusion.
Created by Researcher, 2021.

The following art theories can therefore apply to explain the works of arts: formalist theory, experience theory, expression theory, and organic theory. The formalist viewpoint. As a result, part of the author (Thatree Muangkaew) is ceramic art serves as a tool to test how far the pre-existing art theory can explain the newly development in art work of the 21st century. It is time to propose a new art theory.

There is no mention of expressionism, abstract art, or conceptual art, but we need to have an open mind to embrace Hegel's predictions that it would come 80 to more than 100 years after his death. If this is the case, his famous concepts should be associated with the past, such as late modernism. Finally, Hegel's symbolism of art is referred to as conceptual art or pop art. According to the study, Hegel is correct in the sense that some idealist motifs or art forms of the past that can be burned to new art forms of the future.

6.4 Development in the future

6.4.1 Using fruit ash mixed with different kinds of them.

6.4.2 Using fruit ash mixed with the ashes of different plants.

6.4.3 Experimenting with adding oxide to the fruit ash glaze formula.

6.4.4 Experimenting with common fruits in many places.

6.4.5 Creating the Public Art.

Figure 292 Dry tropical fruits as raw material to making glaze.

Photo by Researcher, 2018

Figure 293 Organic Ceramic Sculpture with Tropical Fruits Ash Glaze.

Made by researcher, 2018 – 2021.

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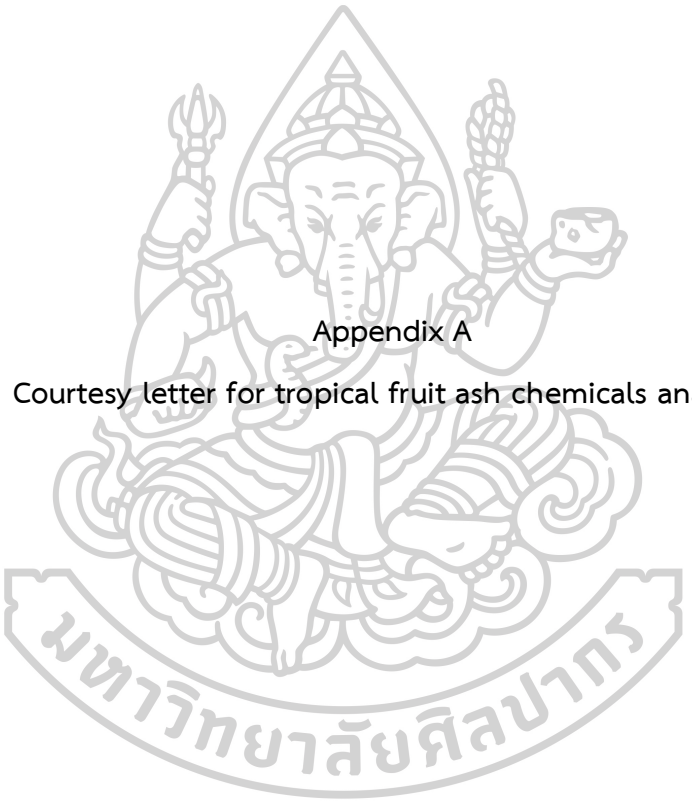
APPENDIX



Appendix A

Courtesy letter for tropical fruit ash chemicals analysis.

บันทึกข้อความ

ส่วนราชการ ภาควิชาเครื่องเคลือบดินเผา คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร โทร.

ที่ / **วันที่** 17 กันยายน 2562

เรื่อง ขอความอนุเคราะห์วิเคราะห์ขี้เถ้าผลไม้ ซึ่งเป็นส่วนหนึ่งของโครงการ *The Organic Ceramic Sculpture with Tropical Fruits Ash Glaze* (วิทยานิพนธ์หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาศิลปะการออกแบบ ของอาจารย์ธาตรี เมืองแก้ว คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร)

.....

เรียน ผู้ช่วยศาสตราจารย์ ดร.ศุภกิจ สุทธิเรืองวงศ์ ภาควิชาวิทยาการและวิศวกรรมวัสดุ
คณะวิศวกรรมศาสตร์และเทคโนโลยีอุตสาหกรรม มหาวิทยาลัยศิลปากร

ด้วยข้าพเจ้า อาจารย์ธาตรี เมืองแก้ว สังกัดภาควิชาเครื่องเคลือบดินเผา คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร ได้ทำหัวข้อวิทยานิพนธ์หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาศิลปะการออกแบบ คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร หัวข้อ *The Organic Ceramic Sculpture with Tropical Fruits Ash Glaze* ซึ่งในโครงการดังกล่าวจะมีการนำผลไม้แห้งไปเผา เพื่อให้ได้ขี้เถ้าแล้วนำไปทำน้ำเคลือบเพื่อนำมาใช้ในการสร้างสรรค์เครื่องเคลือบดินเผา

จึงเรียนมาเพื่อขอความอนุเคราะห์ ผู้ช่วยศาสตราจารย์ ดร.ศุภกิจ สุทธิเรืองวงศ์ ผู้มีความเชี่ยวชาญด้านวิศวกรรมวัสดุให้ช่วยทำการวิเคราะห์ขี้เถ้าผลไม้เพื่อแยกธาตุที่มีอยู่ในตัวอย่างขี้เถ้าผลไม้ 13 ชนิด ตามที่ได้แนบตัวอย่างมา

ด้วยหวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์จากท่าน และหวังว่าโครงการดังกล่าวจะทำให้เกิดองค์ความรู้ใหม่ทางด้านวิศวกรรมวัสดุ และศาสตร์การสร้างสรรค์เครื่องเคลือบดินเผา

จึงเรียนมาเพื่อพิจารณาให้ความอนุเคราะห์จักขอบคุณยิ่ง

.....

(อาจารย์ธาตรี เมืองแก้ว)
อาจารย์ประจำภาควิชาเครื่องเคลือบดินเผา
คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร

Appendix B

Glost firing in a reduction atmosphere.

Glost firing in a reduction atmosphere.

1) The first period: Fire in an oxidation atmosphere at room temperature – 900 c°

2) The second period: Fire in a reduction atmosphere at 900 – 1,200 c°

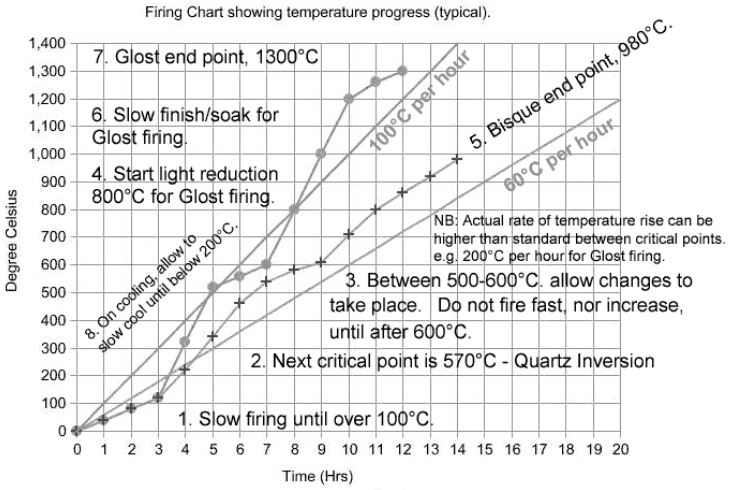
3) The third period: Fire in the oxidation atmosphere at 1,200 – 1,222 c°

4) The fourth period: 15-20 minutes of soaking time at 1,222 c° in the oxidation fire.

Inside the Gas kiln.
Photo by researcher.

The Gas kiln can be use for glost firing in atmosphere reduction and oxidation.
Photo by researcher.

If the glost firing is not reached the vitreous point, the glaze will be more matt than usual, and it is not mature. On the other hand, if the temperature is higher than the vitreous point, the glaze will be unduly glossy and fluid. The excessive melt fluidity of glaze causes the defects. Therefore, the glost firing must be controlled carefully.

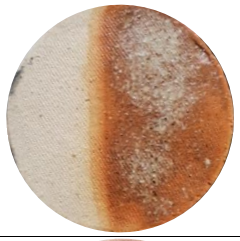
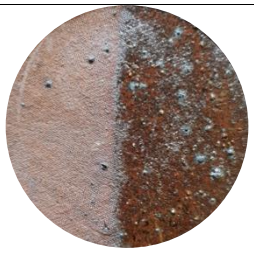


Critical points in firing. Accessed on July 24, 2021. Available from *https://www.oocities.org/peter_stephens/nteonfrg/crtpts.html*

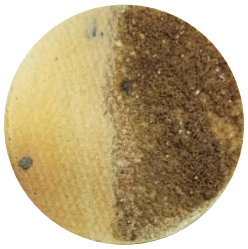
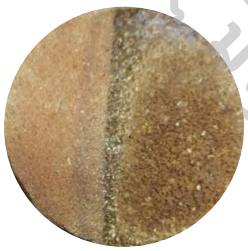
Appendix C

Glaze test result from Pure tropical fruits ash 100%

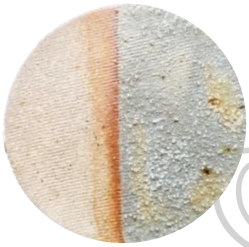
Glaze test result from Pure tropical fruits ash 100%

Cassia fistula (ผลราชพฤกษ์)		
		
Glaze test result	**Detail**	**Remark**
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

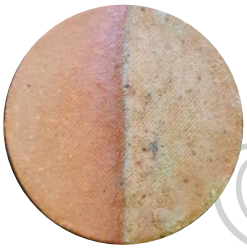
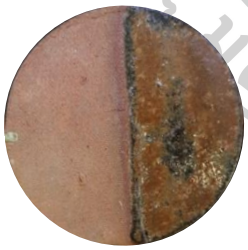
Glaze test result from Pure tropical fruits ash 100%

Coffea robusta Pierre ex Froehner L. (กาแฟ)		
		
Glaze test result	**Detail**	**Remark**
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

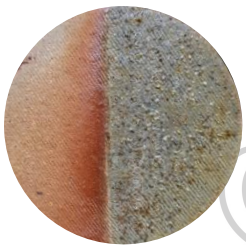
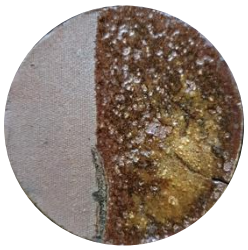
Glaze test result from Pure tropical fruits ash 100%

Delonix regia (ฝักหางนกยูงฝรั่ง)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Glaze test result from Pure tropical fruits ash 100%

Durio zibethinus L. (ทุเรียน)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

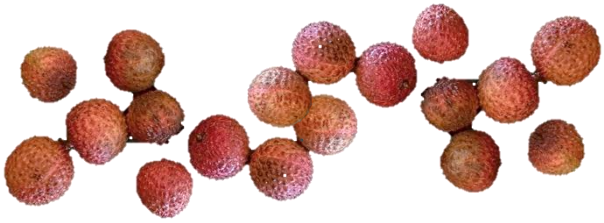
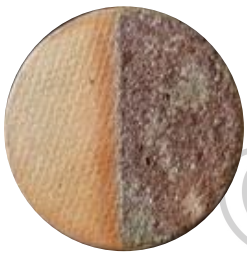
Glaze test result from Pure tropical fruits ash 100%

Garcinia mangostana linn (มังคุด)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Glaze test result from Pure tropical fruits ash 100%

Lagerstroemia floribunda (ผลตะแบกนา)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

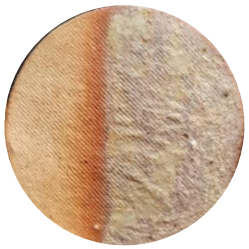
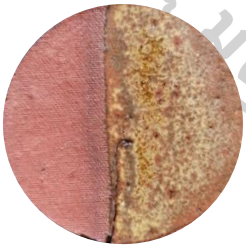
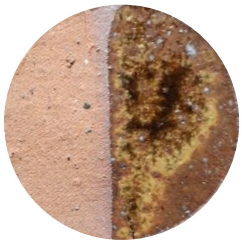
Glaze test result from Pure tropical fruits ash 100%

Litchi chinensis (ลิ้นจี่)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

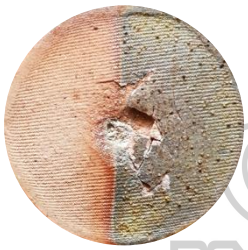
Glaze test result from Pure tropical fruits ash 100%

Nipa fruticana (จาก)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Glaze test result from Pure tropical fruits ash 100%

Peltophorum pterocarpum (นนทรี)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

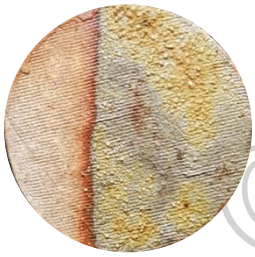
Glaze test result from Pure tropical fruits ash 100%

Shorea robusta (สาละ)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

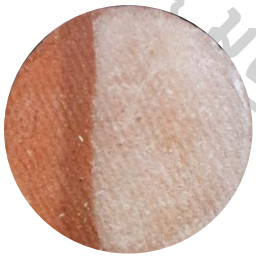
Glaze test result from Pure tropical fruits ash 100%

Sterculia foetida (สำโรง)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Glaze test result from Pure tropical fruits ash 100%

Terminalia catappa (หูกวาง)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Glaze test result from Pure tropical fruits ash 100%

Xylia xylocarpa (ไม้แดง)		
		
Glaze test result	Detail	Remark
	Clay body: Stoneware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Stoneware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Electric kiln Atmosphere: Oxidation Temperature: 1,222˚c	
	Clay body: Earthenware Kiln: Gas kiln Atmosphere: Reduction Temperature: 1,222˚c	

Appendix D

Example tropical fruit ash glaze applied on functional object.

Example tropical fruit ash glaze applied on functional object.

The result of stoneware clay body cup glazing with the durian rind ash glaze. Firing at 1,222 ˚c by electric kiln c by gas kiln in oxidation atmosphere. Size 12x12x12 cm. researcher, 2019.

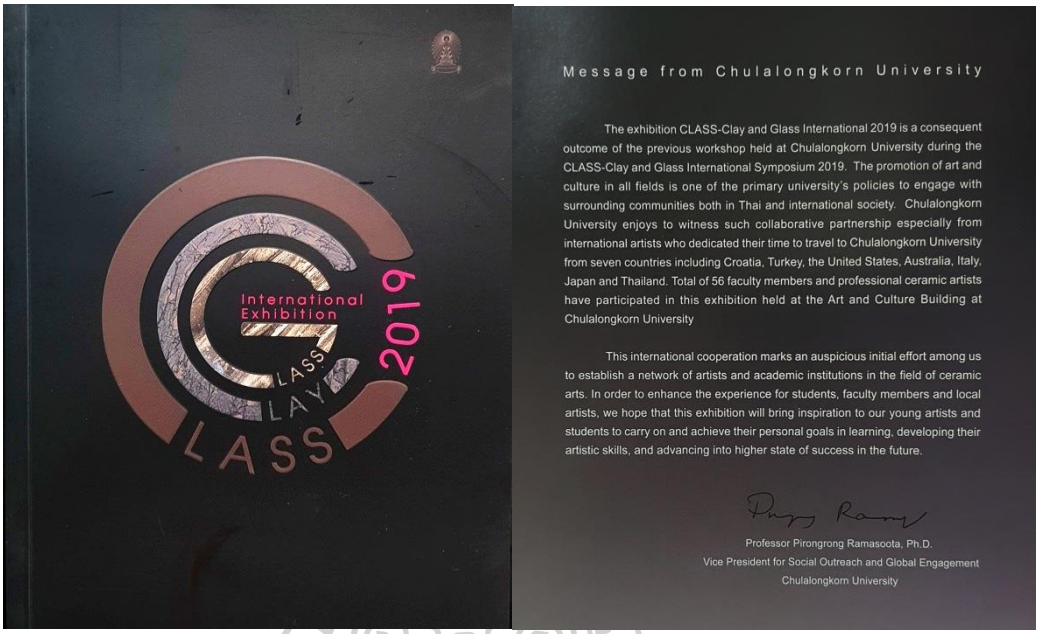
The result of stoneware clay body cup, glazing with the durian rind glaze. Firing at 1,222 ˚ in reduction atmosphere. Size 12x12x12 cm. Photo by Photo by researcher, 2019.

The result of porcelain clay body cup glazing by durian rind ash ash glaze. Firing at 1,222 ˚c by electric kiln kilnin oxidation atmosphere. Size 25x20x60 cm. Photo by researcher, 2019.

Stoneware clay body cup glazing with the durian rind glaze. Firing at 1,222 ˚c by gas in reduction atmosphere. Diameter 35 cm. Photo by researcher, 2019.

Appendix E

CLASS – Clay & Glass International Exhibition 2019



Exhibition Catalog: CLASS – Clay & Glass International Exhibition 2019. 2-6 December 2019 At Exhibition Hall, Art and Culture Building Chulalongkorn University,Bangkok, Thailand. Work title: Sleeping Bird. Technique: Hand forming /Durian Ash Glaze / 1,220 ˚c Reduction. Size W.20 x L.25 x H.20 cm.

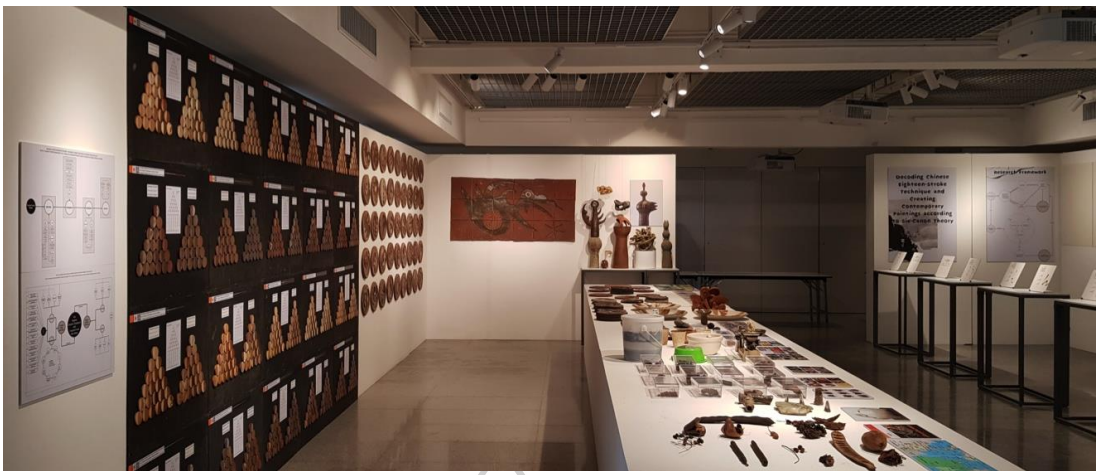
Appendix F

Exploring the Tropical Fruits Waste as Ash Glaze for

Organic Ceramic Sculpture Exhibition at Gallery of Art and Design

Faculty of Decorative Arts, Silpakorn University, Thailand on 2021.

Exploring the Tropical Fruits Waste as Ash Glaze for
Organic Ceramic Sculpture Exhibition at Gallery of Art and Design
Faculty of Decorative Arts, Silpakorn University, Thailand on 2021.

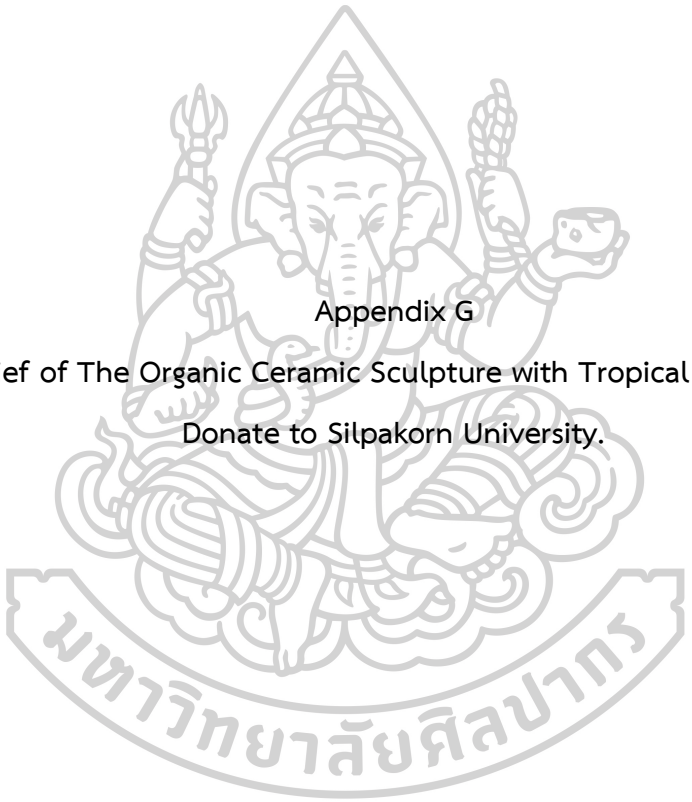


Exploring the Tropical Fruits Waste as Ash Glaze for
Organic Ceramic Sculpture Exhibition at Gallery of Art and Design
Faculty of Decorative Arts, Silpakorn University, Thailand on 2021.





Exploring the Tropical Fruits Waste as Ash Glaze for
Organic Ceramic Sculpture Exhibition at Gallery of Art and Design
Faculty of Decorative Arts, Silpakorn University, Thailand on 2021.



Appendix G

Round relief of The Organic Ceramic Sculpture with Tropical Fruits Ash Glaze, Donate to Silpakorn University.

บันทึกข้อความ

ส่วนราชการ คณะมัณฑนศิลป์ มหาวิทยาลัยศิลปากร **ภายใน** โทร.204004

ที่ อว 8610 นฐ/079 **วันที่** 19 สิงหาคม 2564

เรื่อง ขอมอบผลงานประติมากรรมของผู้ช่วยศาสตราจารย์ธาตรี เมืองแก้ว ที่ได้สร้างสรรค์ในหลักสูตรการศึกษาดุษฎีบัณฑิต สาขาศิลปะการออกแบบ (หลักสูตรนานาชาติ) คณะมัณฑนศิลป์ ให้กับมหาวิทยาลัยศิลปากร

เรียน รองอธิการบดีพระราชวังสนามจันทร์

ตามที่มหาวิทยาลัยศิลปากร วิทยาเขตพระราชวังสนามจันทร์ มีนโยบายการจัดการขยะอย่างสร้างสรรค์ รวมถึงการนำผลงานศิลปะติดตั้งบริเวณพื้นที่ต่างๆ ในวิทยาเขตพระราชวังสนามจันทร์ เพื่อเป็นแหล่งเรียนรู้นอกห้องเรียนและส่งเสริมบรรยากาศความเป็นมหาวิทยาลัยแห่งศิลปะ

ในการนี้ข้าพเจ้า ผู้ช่วยศาสตราจารย์ธาตรี เมืองแก้ว สังกัดคณะมัณฑนศิลป์ ได้เข้าศึกษาในหลักสูตรดุษฎีบัณฑิต สาขาศิลปะการออกแบบ (หลักสูตรนานาชาติ) คณะมัณฑนศิลป์ ในหลักสูตรดังกล่าวข้าพเจ้าได้สร้างสรรค์ผลงานดุษฎีนิพนธ์ภายใต้หัวข้อ "The Organic Ceramic Sculpture with Tropical Fruits Ash Glaze" ซึ่งผลงานที่ได้สร้างสรรค์มีการใช้น้ำเคลือบขี้เถ้าที่เกิดจากการวิจัยโดยการนำส่วนต่างๆ ของผลไม้เมืองร้อนที่เหลือใช้จากการบริโภคมาทำการวิจัยทดลอง โดยนำมาใช้สร้างสรรค์กับผลงานประติมากรรมเครื่องปั้นดินเผาอินทรียรูปที่ได้แรงบรรดาลใจมาจากการเจริญเติบโตของพืช ข้าพเจ้ามีความเล็งเห็นว่าผลงานของข้าพเจ้าตรงกับนโยบายของมหาวิทยาลัยในเรื่องการจัดการขยะอย่างสร้างสรรค์ รวมถึงการนำผลงานศิลปะติดตั้งบริเวณพื้นที่ต่างๆ เพื่อเป็นแหล่งเรียนรู้นอกห้องเรียนและส่งเสริมบรรยากาศความเป็นมหาวิทยาลัยแห่งศิลปะ ข้าพจึงมีความประสงค์มอบผลงานประติมากรรมเครื่องปั้นดินเผาของข้าพเจ้า จำนวน 9 ชิ้น ให้กับมหาวิทยาลัยศิลปากร ไว้ใช้ประโยชน์ตามนโยบายฯ

(ผู้ช่วยศาสตราจารย์ธาตรี เมืองแก้ว)
นักศึกษาดุษฎีบัณฑิต สาขาศิลปะการออกแบบ
(หลักสูตรนานาชาติ) คณะมัณฑนศิลป์
มหาวิทยาลัยศิลปากร
รหัสประจำตัวนักศึกษา 60155914

เรียน รองอธิการบดี พระราชวังสนามจันทร์
เพื่อโปรดทราบ

ทราบ
18 ส.ค. 64
(ศาสตราจารย์ ดร.ศณิต เชียววิชัย)
รองอธิการบดี พระราชวังสนามจันทร์

ที่ อว 8604/0685

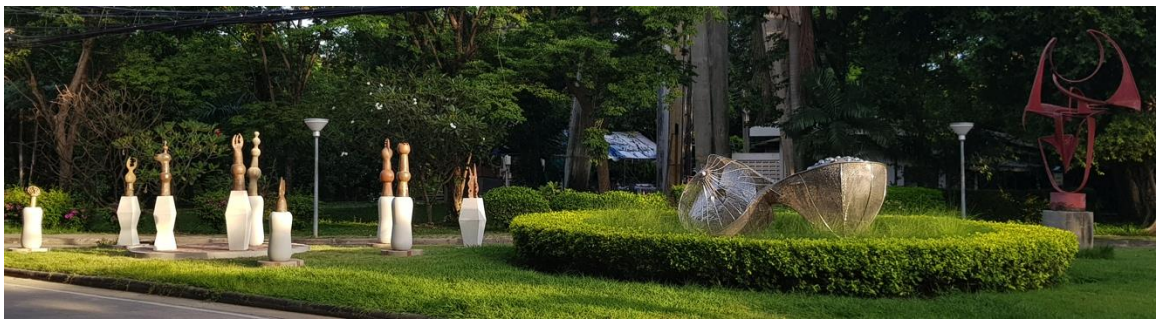
ถึง ผู้ช่วยศาสตราจารย์ธาตรี เมืองแก้ว คณะมัณฑนศิลป์

ตามที่ ผู้ช่วยศาสตราจารย์ธาตรี เมืองแก้ว คณะมัณฑนศิลป์ ได้มอบผลงานประติมากรรม "The Organic Ceramic Sculpture with Tropical Fruits Ash Glaze" ให้กับมหาวิทยาลัยศิลปากร วิทยาเขตพระราชวังสนามจันทร์ นั้น

ในการนี้ มหาวิทยาลัยศิลปากร ได้รับผลงานประติมากรรมดังกล่าวแล้ว ด้วยความขอบพระคุณยิ่ง และหวังว่าจะได้รับความอนุเคราะห์จากท่านอีกในโอกาสต่อไป

มหาวิทยาลัยศิลปากร
วิทยาเขตพระราชวังสนามจันทร์
สิงหาคม 2564

งานบริหารงานทั่วไป
กองงานวิทยาเขตพระราชวังสนามจันทร์
สำนักงานอธิการบดี
โทร. 0-3425-5791
โทรสาร 0-3425-5099



Round relief of Exploring the Tropical Fruits Waste as Ash Glaze for Organic Ceramic Sculpture, Donate to Silpakorn University.

Appendix H

Invitation letter to attend the International Summit Forum on "Development Trend of Contemporary Ceramic Art Education"

held from 2:00PM to 5:30 PM on November 19, 2021.

At Jingdezhen Ceramic University, People's Republic of China.

Invitation Letter

Dear Professor Thatree Muangkaew,

In response to the call of China to build Jingdezhen National Ceramic Culture Inheritance and Innovation Pilot Zone and create a new platform for foreign cultural exchange, the world-renowned millennium ceramic capital Jingdezhen and the century old Jingdezhen Ceramic University are jointly founding and launching "Jingdezhen International Ceramic Art Biennale", which aims to connect Jingdezhen more closely with the world, build a new platform for international and interregional cultural exchanges with ceramic culture as the carrier, so that the world can see and feel China's responsibility and mission for the prosperity and development of world ceramic culture.

"*The Spirit of Ceramics*: -- 2021 Jingdezhen International Ceramic Art Biennale" will be held at Jingdezhen Ceramic University from November 18, 2021. On behalf of Jingdezhen Ceramic University, we sincerely invite you to attend the International Summit Forum on "Development Trend of Contemporary Ceramic Art Education" held from 2:00PM to 5:30PM on November 19, 2021 and make a 6-minute Forum speech.

We thank you in advance for your favorable consideration.

With our best regards,

Prof. Zhang Jingjing
Dean of International School
Jingdezhen Ceramic University
Oct.16th, 2021


THE
SPIRIT
OF 瓷的精神
CERAMICS
ORGANIZER
The People's Government of Jingdezhen Municipality
Jingdezhen Ceramic University
China Arts and Entertainment Group Ltd.
International Academy of Ceramics
CJICB
2021景德镇
国际陶瓷艺术双年展
JINGDEZHEN
INTERNATIONAL CERAMIC ART
BIENNALE 2021

INVITATION LETTER

October, 2021

Dear Professor Thatree Muangkaew,

The opening ceremony of The Spirit of Ceramics: 2021 Jingdezhen International Ceramic Art Biennale, jointly organized by The People's Government of Jingdezhen Municipality, Jingdezhen Ceramic University, China Arts and Entertainment Group Ltd. and International Academy of Ceramics (IAC), will be held at the Xianghu campus of Jingdezhen Ceramic University on November 18th, 2021.

This Biennale is an international academic exhibition which aims to connect China more closely with the world and build a new platform for international cooperation and exchange with ceramic culture as the carrier. As important events of the Biennale, the Launching Ceremony for the International Ceramic Education Alliance and the International Summit Forum on the Future of Contemporary Ceramic Art Education will also be held at the same time.

In view of your great academic and professional achievements in ceramics, you are specially invited to give a video speech for the International Forum on the Future of Contemporary Ceramic Art Education which will be held on 19th November, 2021. The themes of the forum are:

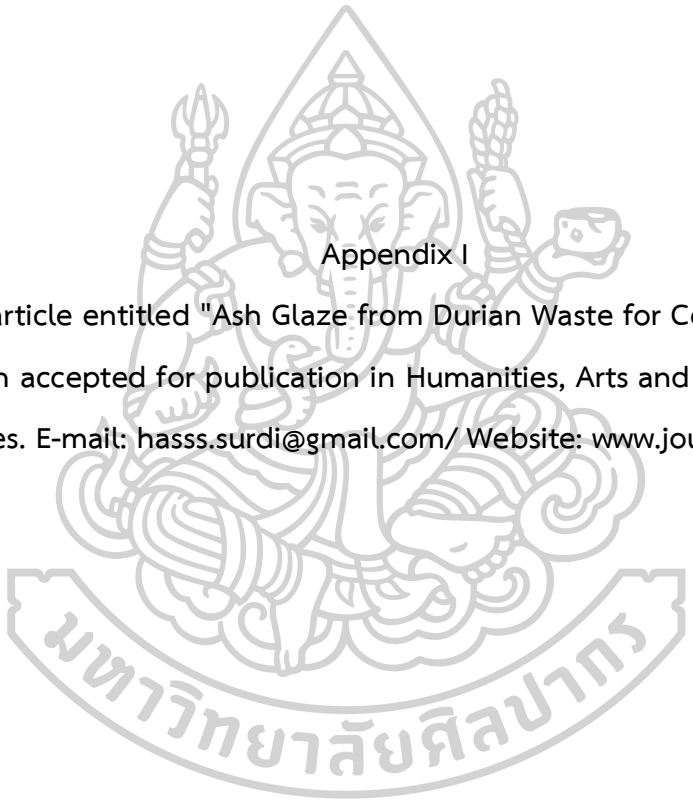
1. The trend of global ceramic art in the age of pandemic
2. The ceramic art innovation and local experiences from the international perspective

We would be grateful for your prompt reply.

Sincerely yours,

The Organizing Committee of Jingdezhen International Ceramic Art Biennale

2021
11/18
2022
02/17



Appendix I

Research article entitled "Ash Glaze from Durian Waste for Ceramic Creations" has been accepted for publication in Humanities, Arts and Social Sciences Studies. E-mail: hasss.surdi@gmail.com/ Website: www.journal.su.ac.th

Humanities, Arts and Social Sciences Studies

Silpakorn University Research, Innovation and Creativity
Administration Office, Sanam Chandra Palace Campus
6 Rajamankha Nai Rd., Amphoe Muang,
Nakhon Pathom 73000, Thailand.

Tel: +66-65070-4679 Fax: +66-3425-5808
E-mail: hasss.surdi@gmail.com
Website: www.journal.su.ac.th

No. 8603.16/4829
November 10, 2021

Dear Thartree Muangkaew,

Your research article entitled "Ash Glaze from Durian Waste for Ceramic Creations" has been accepted for publication in Humanities, Arts and Social Sciences Studies.

Thank you for your contribution to Humanities, Arts and Social Sciences Studies.

Sincerely yours,

Korakoch Attaviriyanupap

(Professor Korakoch Attaviriyanupap, Ph.D.)
Editor-in-Chief of Humanities, Arts and Social Sciences Studies

VITA

NAME	THATREE MUANGKAEW.
DATE OF BIRTH	9 November 1980
PLACE OF BIRTH	Chiang Mai, Thailand.
INSTITUTIONS ATTENDED	- [2005] Bachelor of Fine Arts in Ceramics, Silpakorn University, Bangkok, Thailand. - [2006] Work as a Designer at “Tao Hong Tai” Ceramics Factory Ratchaburi, Thailand. - [2007] Foreign Casual Course in Sculpture, Visva-Bharati University, Santiniketan, West Bengal, India. - [2009] Master of Fine Art in Sculpture, Visva-Bharati University, Santiniketan, West Bengal, India.
HOME ADDRESS	57 Mhu 3 Houysay, Sankamphang District, Chiang Mai Province, Thailand 50130
PUBLICATION	"Ash Glaze from Durian Waste for Ceramic Creations" has been accepted for publication in Humanities, Arts and Social Sciences Studies.
AWARD RECEIVED	Winner Award “Ohng Arng Kratang Soun (Terracotta Sculpture for Garden Contest 2003)” At Seacon square, Bangkok, Thailand.
	PUBLIC ART [2006] Public Sculpture for TaoHongTai Ceramics Factory, Ratchaburi, Thailand. [2013] Public Sculpture for TaoHongTai Ceramics Factory, Ratchaburi, Thailand. [2015] Public Sculpture for Public Library Ratchaburi,

Thailand.

[2017] Public Sculpture for Princess Sirindhorn Art Center Loei, Thailand.

[2017] Public Sculpture for Eskişehir City, Turkey. (11th international

Terra Cotta Symposium 2017)

[2021] Public Sculpture nearby Maeklong river at Ratchaburi Province, Thailand.

EXHIBITION

[2003] “Off Course Exhibition” At Siam Center, Bangkok, Thailand.

[2005] “Art Thesis Faculty of Decorative Arts Exhibition” At Silpakorn University, Bangkok, Thailand.

[2006] “Ceramics Exhibition 6” [Invited Artist] Department of Ceramic, Faculty of Fine Art and Applied Art Burapha University At PlayGround, Bangkok, Thailand.

[2007] “Sculpture Show Exhibition” Department of Sculpture KalaBhavana [Institute of Fine Art] VisvaBharati University, Santiniketan, West Bengal, India. At Nandan Gallery VisvaBharati University, Santiniketan, West Bengal, India

[2008] “JATRI [The Journey Begins] Exhibition” 1stYear MFA. Student of KalaBhavana [Institute of Fine Art] VisvaBharati University, Santiniketan, West Bengal, India At Nandan Gallery VisvaBharati University, Santiniketan, West Bengal, India

[2009] “KALA BAVANA Annual Exhibition 2009” At Academy of Fine Art, Kolkata, West Bengal, India

[2010] “The 15th National Ceramics Exhibition” At the Contemporary Art gallery, Silpakorn University.

Sanamchandra Palace Campus, Nakhon Pathom, Thailand.
[2010] “International Design Current 2010” at Gallery A, Korea Design Center, Korea.
[2011] “4th Exhibition by The Member of Ceramics Divition 2011” At Ucenter Chulalongkorn University, Bangkok, Thailand.
[2011] “The Exhibition of Art and Design by Faculty of Decorative Arts Members on the Occasion of Silpa Bhirasri Day, 15 September 2011 At the Gallery of Art and Design, Faculty of Decorative Arts, Silpakorn University, Bangkok, Thailand.
[2011] “Spring International Design Fair 2011” at Gallery A, Korea Design Center, Korea.
[2012] “5th Exhibition by The Member of Ceramics Division 2012” At Exhibition hall, Faculty of Fine Art and Applied Art, Burapha University, Chonburee, Thailand.
[2012] “The Exhibition of Art and Design by Faculty of Decorative Arts Members on the Occasion of Silpa Bhirasri Day, 15 September 2012 At the Gallery of Art and Design, Faculty of Decorative Arts, Silpakorn University, Bangkok, Thailand.
[2012] “The Exhibition of Professional Pottery Association 2012 with Invited foreign Artist” At Nami Island Gallery, Korea.
[2012] “KSCS International Invitation Exhibition of Color Works” At Seogyodong Xi Gallery, Seoul, South Korea.
[2012] “KSDT International Design Trend 2012” At Korea Design Center Exhibition Center, Korea.
[2013] “Bond Klay Keramic Interantional Art Exhibiton 1st” At TonTann Art Space and Gallery, Khonkaen, Thailand.
[2013] “The 6th International Ceramic Exhibition 2013” by

The Member of Thailand. Ceramics Divition At Sanam Chandra Art Gallery, Silpakorn University Sanamchandra Palace Campus, Nakhon Pathom, Thailand.
[2013] “The 4th Exhibition of Art and Design by The Department of Ceramics Members 2013” At the Gallery of Art and Design, Faculty of Decorative Arts, Silpakorn University, Bangkok, Thailand.
[2013] “The Exhibition of Art and Design by Faculty of Decorative Arts Members on the Occasion of Silpa Bhirasri Day, 15 September 2013 At the Gallery of Art and Design, Faculty of Decorative Arts, Silpakorn University, Bangkok, Thailand.
[2013] “ICTA 2013 International Conference on Traditional and Advanced Ceramics” Bitec, Bangkok,Thailand.
[2013] “Nami Island International Pottery Festival 2013” At Nami Island Gallery, Korea.
[2013] “International Design trend 2013” At Korea Design Center Exhibition Center, Korea.
[2013] “International Design Invitational Exhibition 2013” At Korea Design Center Exhibition Center, Korea.
[2014] “The 7th International Ceramic Exhibition 2014” by The Member of Thailand. Ceramics Divition At Exhibition Hall, Bunditpatanasilpa Institute, Bangkok, Thailand.
[2014] “Bond Klay Keramic Interantional Art Exhibiton 2nd” At Lak Muang Gallery, Khonkaen, Thailand.
[2014] “SelsiusUSM The 5th International Ceramic Festival 2014” Muzium & Galeri Tuanku Fauziah, Universiti Sains Malaysia, Penang, Malaysia.
[2014] “DNA Dsign Network Asean The Exhibition of Art and Design by Faculty of Decorative Arts Members on the Occasion of Silpa Bhirasri Day, 15 September 2013

At the Gallery of Art and Design, Faculty of Decorative Arts, Silpakorn University, Bangkok, Thailand.

[2014] “Ingredients of Happiness Ceramic Exhibition” At Monsoon Restaurant and Bar, Saigon, Vietnam.

[2014] “The Traces of Nomadian Artists meet The Contemporary Potters” At Gallery Sein, Seoul, Korea.

[2014] “Cubic Museum by Silpakorn University and Aichi University of Arts” At Art Gallery Silpakorn University, Bangkok, Thailand.

[2014] “KSDT International Design Invitational Exhibition 2014” At Kukjae Art Museum, Keimyung University, Korea.

[2014] “KSDT International Design Trend 2014” At Korea Design Center Exhibition Center, Korea.

[2015] “Bond Klay Keramic Interantional Art Exhibiton 3rd” At Exhibition Hall, Khonkaen University, Khonkaen Khonkaen, Thailand.

[2015] “International Conference & Design Exhibition” At Korea Design Center Exhibition Center, Korea.

[2015] “International Workshop on Art and Exhibition 2015” At Exhibition Hall, Antalya Metropolitan Municipality, Olympos, Turkey.

[2015] “2015 China (Beijing) International Macsabal Wood Fire Festival” Beijing, China.

[2016] “International Ceramic and Plastic Art Exchange Program 2015” Namseoul University, Korea.

[2016] “Thailand. – International Ceramic Symposium SANAMCHANDRA CLAY WORK” At the Contemporary Art gallery, Silpakorn University, Sanamchandra Palace Campus, Nakhon Pathom, Thailand.

[2016] “International Invitational Design Exhibition in Spring” At Art Center of Pusan National University, Korea.

[2016] “XXIII. International Raku Workshop and Exhibition” At Oblikovna likovna radionica Plemenitas, Croatia

[2016] “International Invitational Design Exhibition in autumn 2016” At Korea Design Center, Korea.

[2016] “The 18th National Ceramics Exhibition” At the Contemporary Art gallery, Silpakorn University Sanamchandra Palace Campus, Nakhon Pathom, Thailand.

[2016] “BKK IV” The 4th International Contemporary Ceramic Art Project “Contemporary Ceramic Lantern” at Sithan Art Space, Khon Kaen University, Thailand.

[2017] “Bond Klay Keramic V” the 5th International Contemporary Ceramic Art Workshop and Conferrence . At Valaya Alongkorn Rajabhat University. Thailand.

[2017] “Considerateness in Design” At Ratchadamnoen Contemporary Museum, Bangkok, Thailand.

[2017] “Ingredients of Happiness” At Case Space Revolution. Sukhumvit 49 Bangkok, Thailand.

[2017] “The 2st International Architecture Ceramics Exhibition 2017” in collaboration with Public Air Art Gallery in Cheongju City and Namseoul University, Korea.

[2017] “11th International Terra Cotta Symposium 2017” in Eskişehir City, Turkey.

[2017] “2017 Pacific Rim International Exhibition” At Silpakorn University, Thailand.

[2017] “Silpakorn Clay work International RAKU Sculpture Symposium 2017” Silpakorn University, Thailand.

[2018] “Bond, Klay, Keramic VI” At Buriram Rajabhat University, Buriram Province, Thailand.

[2018] “International Invitational Design Exhibition 2018” At Korea Design Center Exhibition Center, Korea.

[2018] “International SALON OF CERAMIC; firing event,

exhibition and workshops 2018" At the Gallery Unterer Hardthof, Gießen, Germany.

[2019] "Bangkok Design Week" At Pa Prank Design Hostel Bangkok, Thailand.

[2019] "Silpakorn Clay Work Phetchaburi International Raku Sculpture" At Silpakorn University Phetchaburi Campus, Thailand.

[2019] "1st CHIANGMAI International Ceramic Arts and Culture Symposium" At TCDC Chiangmai and Chiangmai Art and Culture Center, Thailand.

[2019] "The exhibition SUBURBS: A STUDY ABOUT" At Palazzo Martinengo Cesaresco 30, via Musei, Brescia,Italy.

[2019] "Pacific Rim International Exhibition" At Art Gallery of A.M FEDOTOV (Khabarovsk city, K.MARX STR., 47) Russia.

[2019] "International Art Exhibition and Academic Collaboration" At Art and Design Gallery, Faculty of Decorative Arts, Silpakorn University, Thailand.

[2019] "Chiang Mai Design Week" At Chiangmai Art and Culture Center, Thailand.

[2019] "CLASS Clay and Glass International Symposium" At Chulalongkorn University, Bangkok, Thailand.

[2019] "International Design Invitational Exhibition" At Korea Design Center, Seoul, Korea.

[2020] "Silpakorn Clay Works" At Silpakorn University Sanamchandra Campus, Nakorn Pathom, Thailand.

[2020] "2020 The 15th International Visual Arts Workshop and Exhibition in Thailand." At PohChang Academic of Fine Art, Bangkok, Thailand.

[2020] "KSDT International design Invitational Exhibition 2020" At Korea Design Center Exhibition Center, Korea.

[2020] "2020 Chiangmai Pit Firing Friendship" At

Chiangmai Cultural Center, Chiangmai City Thailand.
[2020] “Chiang Mai Design Week” At Chiangmai Art and Culture Center, Thailand.
[2020] “LOST & FOUND International Contemporary Ceramics Art Exhibition” At Yelo gallery, Bangkok, Thailand.
[2021] “Chiangmai Pit Firing Friendship 2021” At Chiangmai Art and Culture Center, Chiangmai, Thailand.
[2021] “Chiangmai Design Week 2021” At Chiangmai Art and Culture Center, Chiangmai, Thailand.