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Research

Documentation of Plant-Based Food Wrapper Utilised by Communities in Bintulu, Sarawak

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ABSTRACT

Usage of wrapping or packaging is very significant in food processing to protect, secure, and provide a specific image of the food contained. Around 10,000 years ago, food wrappers were developed by our ancestors using natural substances such as animal skins, tree stems, and leaves. There is limited information on food wrappers based on Sarawak's natural resources. However, among the older Sarawak communities, such knowledge is present and valuable. Unfortunately, this information is on the verge of extinction due to a lack of documentary. Therefore, this study was conducted to identify and document the plant-based food wrappers used by the communities in Sarawak. An ethnobotanical study was conducted using face-to-face interviews with 384 respondents. The study was conducted in a semi-structured manner from December 2021 until May 2022. A total of 21 species of plants from 11 different families has been identified as food wrapper by the community in Bintulu, Sarawak. The community dominantly used leaves as food wrappers because they can be handled easily and enhance the aroma of the food. Some plant-based food wrapper gives a distinct flavor and aroma to the food when applied with heat. Plant-based food wrappers also had huge potential as more than 90% of respondents were satisfied with the usage and suggested that these wrappers be developed into ready-made form. Locals also informed that plant-based food wrappers can help to expand their economic profit, especially for sellers. Therefore, this study was able to discover the indigenous plant species utilized as traditional food wrappers that have been forgotten. However, further study about the nutritional composition, fiber structure, antibacterial ability, and volatile compound of the species can be conducted to provide a full record of the plants, especially as food aroma enhancers.

Key words: Aroma enhancer, biodegradable, food plant, packaging, traditional knowledge

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INTRODUCTION

Beginning at the earliest period, foods that have been found or caught will be directly consumed by humans which caused minimal need for packing of products, either for transportation or storage (Berger, 2002). As human civilization started to grow, food packing was invented by utilizing natural materials including animal skins, tree stems, and leaves around 10, 000 years ago (Mhd Nor *et al*., 2018). Due to social advancements and people moving goods frequently and in large numbers, it became necessary to wrap food as protection (Mustafa *et al*., 2012). Population growth, rapid urbanization, and other socioeconomic factors also contributed to the creation of food wrappers (Adejumo and Ola 2008; Adebayo & Ojo, 2012). Currently, there is a demand for food wrappers due to the necessity for food preservation, transportation, sampling, selling, and storage. According to Julianti and Nurminah (2006), food wrappers shield food from factors that can injure and impair the quality of a food product such as heat, humidity, air, oxygen, impact, contamination from dirt, and pathogens.

In Malaysia, a plant-based food wrapper is usually utilized in a traditional dish. Wrapping food using natural sources especially leaves can help to elevate the flavor and aroma of the food (Ibrahim and Jamaluddin, 2007; Ojekale *et al*., 2007; Ismail *et al*., 2021). According to Rini *et al*. (2017), leaves that are used for food wrapping will release the flavor

compound when in contact with heat. For instance, banana leaves were used as wraps for foods that will be steamed, baked, roasted, or grilled. It acts as protection by protecting the packed components from direct flame burning while also adding aroma to the flavor of the food (Kora, 2019). Different plant species have different distinct and unique aromas when utilized as food wrappers (Ibrahim & Jamaluddin, 2007). This helped to increase the sensory value of the food wrapped. Plant-based food wrapper also represents the unique value of the product, giving it a distinct personality that adds to its value. The traditional packaging features many complexities of forms that make the entire appearance fascinating and functional. Mustafa *et al*. (2012) also stated that traditional packaging aids the expression of local identity. Rini *et al*. (2017) stated that traditional food wrapped in the plant based-food wrappers can be stored for a longer period, for instance, the “kue bongkol” that is wrapped using the “daun kabung” can be stored for up to 4 days while food that is wrapped using the “daun simpur” usually can be store for up to 5 days.

There is limited information regarding food wrappers based on Sarawak indigenous plant species. However, such knowledge is retained among the elder Sarawak communities. This knowledge is on the edge of extinction, especially among younger generations due to the widespread use of modern and synthetic packaging compared to natural food packaging. The people's inability to easily procure plant materials was also seen as a barrier to their usage as food wrappers. It is well known that various regions of Sarawak have various plant species that were used as a wrapper for the same dish. Furthermore, due to Sarawakians' fondness for contemporary packagings like polystyrene boxes and paper wrappers, there are not many plant-based food wrappers recorded for the utilisation in food packaging especially indigenous species such as *Dillenia suffruticosa* (simpur), *Donax grandis* (bemban), and *Macaranga bancana* (daun wonihan). Therefore, more information about the plant-based food wrappers used by communities needs to be made public. The objective of this study was to record the plant species used by the communities in Bintulu, Sarawak as plant-based food wrappers and to evaluate the application technique of the plant-based food wrappers.

MATERIALS AND METHODS

Study design

The study was conducted using the questionnaire research approach and the interviews were done using the semi-structured method. The semi-structured method was used as it is more consistent with the research ethics that emphasize quantitative research and have a more flexible framework (McIntosh & Morse, 2015). Besides that, using semi semi-structured method allows the respondents to give relevant information on the local practices (O'Keeffe *et al*., 2016).

Study area

This study was conducted around Bintulu Division which is one of the divisions in Sarawak, Malaysia. Bintulu is located in the central region of Sarawak and the nearest division is Miri, Mukah, and Sibu. Bintulu division can be separated into three districts which are Bintulu town, Tatau, and Sebauh. The survey was conducted around settlement areas and markets in the three districts.

Data collection

The survey was conducted for 6 months effective from December 2021 until April 2022 using a semi-structured method. 384 respondents residents from different indigenous races participated in this study based on Krejcie and Morgan (1970) formula. Respondents who were not local and Sarawak indigenous people were excluded from this study. A simple random sampling technique was chosen as it can derive inferences from a study's results are a random selection that is impartial and a representative sample (Sharma, 2017). However, questionnaires were mainly distributed to middle-aged and elderly to avoid any problem of losing information that could lead to inaccurate documentation regarding the subject. Information for this study was collected based on the answers given by the respondents according to the survey questionnaire. For this study, a well-structured questionnaire consisted of four sections namely; respondents’ personal information, basic information about plant-based food wrappers, and the utilization mode of the plant-based food wrapper. Questionnaires were distributed to the respondents that willing to participate in the field survey. Before completing the survey, each respondent received a briefing and interviewers helped illiterate respondents complete the survey forms.

Statistical analysis

Statistical Package for the Social Sciences version 23.0 was used to compute the data, obtain the frequencies, and conduct the descriptive analysis. The mean score, median, and standard deviation of the respondents were determined using the descriptive analysis.

RESULTS AND DISCUSSION

Respondent's demographic

Diverse ethnicities in the Bintulu Division were recorded throughout this study and dominated by the Ibans with the highest percentage of respondents (54.4%). Then, followed by Melanau (17.2%), Kedayan (14.8%), Malay (8.90%), Bidayuh (1.80%), Kenyah, and Chinese (0.8%), meanwhile respondents from Bisaya, Dusun, Kadazan, Kejaman, and Rungus only 0.3% (Figure 1a). According to the 2010 Census report by the Malaysia Department of Statistics on the overall population of the Bintulu, the Ibans ethnic made up the largest percentage of Bintulu's population, with 42%, as compared to other ethnic groups' percentages, which were as follows: Chinese (21%), Melanau (12%), Malays (10%), and other indigenous tribes (14%) (Magiman *et al*., 2020). Each ethnicity possesses different traditional knowledge and utilization methods of the plant-based food wrapper. Iban also known as Sea Dayak is the main ethnic group in Sarawak which comprises the largest population with more than 53% of the total population in Sarawak (Islam *et al*., 2020). Iban populations have always lived in longhouses in rural locations and along riverbanks; as a result, they engage in non-traditional forms of farming like hunting and foraging for wild vegetation (Saupi *et al*., 2020). This also allows the community to have easy access to forests and wild areas to collect wild plants. Joe and Insham (2004) wrote that indigenous communities especially the Dayak rely heavily on the natural resources in their nearby environment, and their native knowledge is based on how to use and manage those resources.

The study was mostly participated by a female 72.70% compared to males with only 27.3% (Figure 1b). van Rensburg *et al*. (2007) surmised that women in Africa played a key role in the preservation of traditional knowledge. This may also be the case in Bintulu, Sarawak. Women tend to have more traditional knowledge of plants as they are mainly responsible for both the collection and cooking of the plants (Saupi *et al*., 2020). Md. Sharif *et al*. (2013) stated that women, grandmothers, and mothers oversee passing down the traditional cuisine knowledge to the future generations. As shown by Chenhall (2011) in comparison to males, Malay women, grandmothers, and mothers are largely responsible for the preparation of the food at home and have better ability with cooking and food preparation skills. Based on previous studies, it has shown that women are more involved in the preparation of traditional cuisine which also involves the usage of plant-based food wrappers.

In terms of age, 29.7% of the respondents were aged from 45 to 54 years old, 21.4% of 25 to 34 years old, 20.9% of informants were above 55 years old and only 6.3% of the study respondents were between 18 to 24 years old (Figure 1c). Based on the result, middle-aged respondents showed the highest percentage compared to other age ranges. This is because these respondents were more approachable, present at the study site during the survey, can be considered elderly, and may possess suitable knowledge regarding the survey issue. The elderly are seen as a significant national resource with adaptable and useful information that has been passed down from generation to generation by oral or trial techniques. As a result, seniors are regarded as society's "knowledge storage and processing unit" (Dixit & Goyal, 2011). Traditional knowledge is normally passed down from one generation to the next (Yusli *et al*., 2021). Disruptions in knowledge transmission can significantly impair traditional knowledge systems within one or two generations because most knowledge is passed down verbally and is not documented or recorded (Puschkarsky & Noriega, 2013). The present study targeted respondents from the middle-aged to elderly demographic. The selection of the age range was decided to prevent any missing traditional knowledge. Much research conducted on traditional knowledge showed that traditional knowledge was found to be disregarded by newer generations. People of a younger age typically lack adequate conventional knowledge. (Yusli *et al*., 2021). The younger generation may not possess the knowledge because lack of practices and urbanization that cause them to establish modern sources more than traditional options. The younger generation has a propensity to rely more on synthetic sources and disdain for engaging in the practice of traditional knowledge (Md. Sharif *et al*., 2013). Thus, young-aged respondents were the least targeted for this study which caused the lowest percentage in the finding.

About 54.4% of respondents work as a seller (Figure 1d). This is due to the high utilization of the food wrappers among the seller not only to sell the plant itself but also to sell the foods, fruits, and vegetable that is wrapped with plant-based food wrapper. According to Ezeudu *et al* (2021), the food items that are wrapped using vegetable leaf wrappers are mostly sold by sellers at canteens, local markets, street food shops, hawkers, food centers, and restaurants. In terms of the living area of the population, there were 47.1% of respondents from the sub-city followed by village, city, and rural areas with percentages of 44.5%, 7.8%, and 0.5% respectively (Figure 1e). This study was done in the whole Bintulu area which included Tatau, Sebauh, Kuala Tatau, Setiam, Ulu Sebauh, and Kuala Nyalau whereby these areas were considered as the sub-city district in Bintulu. According to a previous study by Bhattarai *et al* (2009), many wild plants were marketed commercially which is of benefit to both the local economy and the local health. Also, Ezeudu *et al* (2021) mentioned that the scarcity of natural food wrappers had sparked a new trend where the leaves were sold at urban marketplaces.

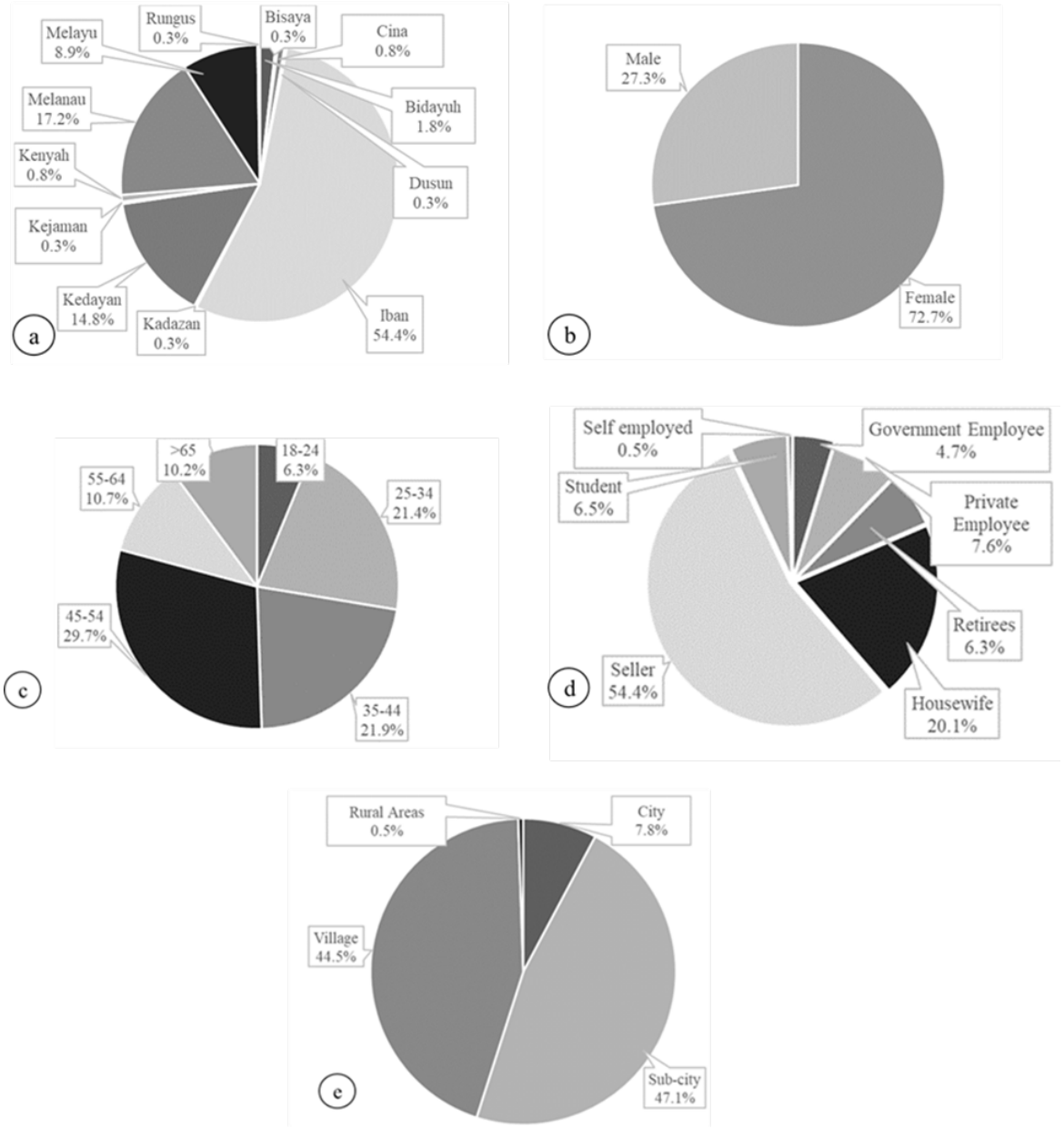

Fig. 1. Demography of respondents in Bintulu: (a) ethnicity of respondents, (b) gender of respondents, (c) age of respondents, (d) occupation of respondents, and (e) living area of respondents.

Diversity of plant-based food wrapper

About 21 species from 11 different families of plants were found used by local communities as plant-based food wrappers (Table 1 & Figure 2). Arecaceae was the dominant family with eight species. Followed by Marantaceae and Poaceae with two species respectively. Eight other families that were identified were Euphorbiaceae, Combretaceae, Zingiberaceae, Nepenthaceae, Araceae, Pandanaceae, Dilleniaceae, and Musaceae only recorded with one species. The Arecaceae plant family is thought to be one of the most crucial to human survival (Sari *et al*., 2019). In addition, Nuryanti *et al*. (2015) stated that the *Cocos nucifera* that comes from the Arecaceae are used to wrap the traditional dish named “ketupat” as the leaf is easy to be woven. Besides that, Rambey *et al*. (2021) reported that the wide leaves of the Arecaceae are suitable to be used as food wrappers. Rini *et al*. (2017) mentioned that Arecaceae have strong leaf fiber, which makes them difficult to tear and can make food last longer. Therefore, factors such as the availability, ability to be woven, durability, and the ability to prolong the shelf life of the food may be the cause for the species from this family to be widely used as food wrappers by the community.

Table 1. The description of the plant species used as food wrappers by locals in Bintulu

SpecieS	Family	Common name	Habit	Habitat	Availability	Plant part
Areca catechu L.	Arecaceae	Upih Pinang	Tree	On land	Wild	Sheath
Cocos nucifera L.	Arecaceae	Daun Kelapa	Tree	On land	Cultivated	Leaves
Colocasia esculenta (L.) Schott	Araceae	Daun Keladi	Herb	On land	Cultivated	Leaves
Curcuma longa L.	Zingiberaceae	Daun Kunyit	Herb	On land	Cultivated	Leaves
Dillenia suffruticosa (Griff.) Martelli	Dilleniaceae	Daun Simpur	Shrub	On land	Wild	Leaves
Donax grandis (Miq.) Ridl.	Marantaceae	Daun Bemban	Tree	In water	Wild	Leaves
Elaeis guineensis Jacq.	Arecaceae	Daun Sawit	Tree	On land	Cultivated	Leaves
Indocalamus tessellatus (Munro) Keng f.	Poaceae	Daun Buluh	Grass	On land	Cultivated	Leaves
Licuala bintulensis Becc.	Arecaceae	Daun Silat	Tree	Forest	Wild	Leaves
Licuala grandis H.Wendl.	Arecaceae	Daun Palas	Tree	On land	Wild	Leaves
Licuala petiolulata Becc.	Arecaceae	Daun Biru	Tree	Forest	Wild	Leaves
Licuala spp.	Arecaceae	Daun Iseng	Tree	Forest	Wild	Leaves
Macaranga bancana (Miq.) Müll.Arg.	Euphorbiaceae	Daun Wonihan	Tree	On land	Wild	Leaves
Musa spp.	Musaceae	Daun Pisang	Herb	On land	Cultivated	Leaves
Nepenthes ampullaria Jack	Nepenthaceae	Periuk Kera	Climber	Forest	Wild	Leaves
Nypa fruticans Wurmb	Arecaceae	Daun Apong	Tree	In water	Wild	Leaves
Pandanus amaryllifolius Roxb.	Pandanaceae	Daun Pandan	Tree	On land	Cultivated	Leaves
Phacelophrynium maximum K.Schum	Marantaceae	Daun Long	Herb	On land	Wild	Leaves
Phrynium pubinerve Blume	Marantaceae	Daun Lerek	Herb	Habitat	Cultivated	Leaves
Schizostachyum brachycladum (Kurz ex Munro)	Poaceae	Buluh	Grass	On land	Cultivated	Diaphragm
Terminalia catappa L.	Combretaceae	Daun Ketapang	Tree	On land	Cultivated	Leaves

Fig. 2. Plant species that are used for plant-based food wrappers: (a) *N. ampullaria,* (b) *N. fruticans,* (c) *C. longa,* (d) *P. maximum,* (e) *L. petiolulata,* (f) *P. amaryllifolius,* (g) *I. tessellatus,* (h) *Musa spp,* (i) *S. brachycladum,* (j) *D. suffruticosa,* (k) *A. catechu,* (l) *T. catappa,* (m) *E. guineensis,* (n) *M. bancana,* (o) *C. esculenta,* (p) *C. nucifera,* (q) *L. grandis,* (r) *L. bintulensis,* (s) *Licuala .spp,* (t) *P. pubinerve,* and (u) *D. grandis*

From the findings, five growth forms were identified; tree, herb, grass, shrub, and climbers as the growth form of the plant species recorded in this study (Table 1). Twelve plant species were categorized into trees which are *Areca catechu, Cocos nucifera, Donax grandis, Elaeis guineensis, Licuala bintuluensis, Licuala grandis, Licuala spp. Macaranga bancana, Nypa fruticans Pandanus amaryllifolius,* and *Terminalia catappa.* Six species were categorised as herbs; *Colocasia esculenta, Curcuma longa, Musa spp*., *Phacelophrynium maximum,* and *Phrynium pubinerye.* Two species were categorised as grass: *Indocalamus tessellatus, and Schizostachyum brachycladum.* One species is a shrub; *Dillenia suffruticosa* and one species is a climber*; Nepenthes ampullaria.* This study recorded more plant species that were tree compared to the study conducted by Lin *et al*. (2019) in China which reported that most plant habit used as plant-based food wrapper were herb followed by trees and no presence of shrub or climber were documented. Based on the preliminary interview, the tree is usually chosen because of its availability in the forest where no cultivation is needed.

Aside from that, the leaves on the tree are usually chosen since plucking them is less likely to cause damage to the tree (Kora, 2019). This study recorded that the leaf was the dominant plant part used by the communities in Bintulu for wrapping purposes meanwhile one species was recorded for the sheath and another species for the diaphragm section. As a result of an interview with the respondents, it was discovered that the leaves were usually utilized as wrappers due to their ease of wrapping, ability to be folded according to the food shape, and sturdiness. Respondents also informed that leaves need the shortest time to prepare compared to other parts which also can help to shorten the cooking time. Many previous studies have been reported regarding the use of plant leaves to wrap food in many countries and regions (Lin *et al*., 2019). In addition, leaves such as banana leaves are commonly used due to their flexibility, and durability, and can be folded easily (Harijati *et al*., 2013). It is also known that wrapping food using plant leaves was considered a food art (Ibrahim & Jamaluddin 2007).

Three types of wrapping surfaces were identified in this study; smooth, rough, and hairy. Nineteen of the species had smooth surfaces, one species had rough surfaces, and one species had hairy surfaces respectively. According to Sahari *et al* (2017), one of the leaf selection criteria used for food wrappers is that the leaves need to have a smooth surface on at least one side to ensure that the leaf can retain and not contaminate the food. Respondents also informed that smooth surface leaves were commonly chosen because there is less tendency to contaminate the food and using the smooth surface can avoid the itching sensation from the hairy surface of the plants. A few species required certain parts to be discarded from the leaves to ease the folding process and prevent it from ripping. For instance, the *C. nucifera* midrib needs to be removed before being utilised because this species has a hard midrib that difficult the folding process difficult and causes the leaves to tear which also causes leakage of packaged food. However, the leaves have still been selected for utilization as food wrapper after the midrib removal due to blade flexibility which ease the folding process and the leaves can improve the aroma of the food wrapped.

Few plant-based food wrappers also possess various aromas which elevated the aroma of food wrapped. This study documented that *D. suffruticosa* and *N. fruticans* emit fresh aroma, *I. tessellatus* emits an umami aroma, meanwhile, *L. grandis, M. bancana, Musa* spp., *N. amppullaria, P. pubinerve, P. amaryllifolius, S. brachycladum,* and *T. catappa* emits a sweet aroma. Based on a previous study done by Rini *et al*. (2017) food wrapped using leaves usually will emit a pleasant aroma and will have a specific taste. Lascurain *et al*. (2017) studied that depending on the plant species, certain leaves can modify the food's flavor profile. Rini *et al*. (2017) mentioned that the usage of the banana leaf to wrap the rice can improve the aroma which can make the rice more delicious while according to Mustafa *et al*. (2012) the usage of the pandan leaf to wrap the "tepung pelita" can release aroma and enhance the flavor of the food. Hence, the usage of the plant-based food wrapper should be vaster as it can enhance the aroma and flavor of the food which will make it more appetizing.

Utilization of plant-based food wrapper

This study recorded seven preparation methods used before the wrapping process (Table 2). Processing of plant-based food wrappers is very important to ensure the cleanliness of the plant before it can be used. There are various ways to process the leaves for instance by wiping, drying, soaking, heating, washing, and oiling. Two plant species must be soaked before wiping, whilst fourteen plant species only needed to be cleaned before use. There is only one species available for each of the other preparation techniques. Based on the previous study reported by Rini *et al* (2017) it is important to wipe the leaves before using it to remove any dirt or dust from the leaves. Ng (2015) stated that some leaves need to be pre-softened before using pre-heating methods such as grilling, boiling, and steaming. Hence, it is advisable to clean the food wrappers with a clean source of water to prevent the growth of microorganisms in the food (Adegunloye *et al*., 2006).

This study documented several different folding shapes used to package the food. About various folding shapes, such as the elongated cone, flat wrap, roll, woven, and closed wrapped, fourteen plant species utilized the closed wrap method, two species did not require any kind of folding method, and one species used each of the other folding shapes. Mustafa *et al* (2012) stated that the chosen folding

Table 2. Description of the utilization of plant-based food wrapper

Species	Wrapping Surface	Discarded plant parts	Aroma/flavor produced	Food consistency	Type of food	Shelf-life	Stage of the plant
A. catechu	Rough	The outer layer of the palm sheath	Bland	Solid	Glutinous rice	1 week	Matured part
C. esculenta	Smooth	None	Bland	Solid	Tapai	2 days	Matured part
C. longa	Smooth	None	Bland	Solid	Grilled fish	1 day	Matured part
C. nucifera	Smooth	Midrib of the leaf	Bland	Solid	Ketupat	1 week	Matured part
D. grandis	Smooth	None	Bland	Solid	Rice	1 day	Matured part
D.suffruticosa	Smooth	None	Fresh	Solid	Rice	3 days	Matured part
E. guineensis	Smooth	None	Bland	Solid	Vegetables	3 days	Matured part
I. tessellatus	Smooth	None	Umami	Solid	Bak Chang	1 week	Old part
L. bintuluensis	Smooth	None	Bland	Solid	Glutinous rice	3 days	Matured part
L. campestris	Smooth	None	Bland	Solid	Kelupis	3 days	Matured part
L. grandis	Smooth	The tip and end part of the leaf	Sweet (Pandan like)	Solid	Ketupat, kelupis	3 days	Matured part
L. petiolulata	Smooth	None	Fresh	Solid	Glutinous rice	1 week	Matured part
M. bancana	Smooth	None	Sweet	Solid	Rice	3 days	Matured part
Musa spp.	Smooth	Midrib of the leaf	Sweet	Solid and semi solid	Nasi lemak, grilled fish, pulut panggang, tepung pelita	1 day	Matured part
N. ampullaria	Hairy	None	Sweet	Solid	Glutinous rice	2 days	Matured part
N.fruticans	Smooth	None	Fresh	Solid and semi-solid	Celorot, rice, ketupat	1 day	Matured part
P. maximum	Smooth	None	Bland	Solid	Kelupis	1 week	Matured part
P. pubinerve	Smooth	None	Sweet (Vanilla like)	Solid and semi solid	Tepung pelita, ketupat, kuih tako	1 day	Matured part
P.amaryllifolius	Smooth	None	Sweet	Solid	Rice	1 week	Matured part
S. brachycladum	Smooth	None	Sweet	Solid and liquid	Lemang, pansuh	2 days	Matured part
T. catappa	Smooth	None	Sweet	Solid	Rice	7 days	Matured part

shape contributes to several elements, including cooking time, usage, containment, flavor enhancer, appearance, and packaging. The commonly used folding shape in this study is the closed wrap. Closed wraps are usually rectangular and usually used for steaming (Sahari *et al*., 2018). Besides that, based on the results two species did not require any folding such as the usage of *Nepenthes ampullaria* and *Schizostachyum brachycladum*. This is because the food can be directly poured inside the wrappers and cooked without any folding. For woven, it is usually for a traditional steamed rice dish called "ketupat" in which the leaf strips are intertwined to create a cube shell that will be filled with rice (Mustafa *et al*., 2012).

The wrapping of food can happen at various stages of cooking. A total of 18 different plant species were used to wrap the food before cooking, two for food that had already been prepared, and one just for storage. According to a previous study in rural Sarawak, the cooked rice is usually wrapped in leaves for the men to take to work in the field Ng (2015). Food such as "pulut panggang" and "otak-otak" are wrapped in banana leaves before grilling. Grilling will enhance the flavor and aroma of the food (Mustafa *et al*., 2012). According to the respondents, the "tapai" will be cooked and wrapped by using leaves before allowing further fermentation. All the plant species are capable of wrapping solid food while only a few species such as *Musa spp*., *N. fruticans*, *P. amaryllifolius,* and *S.brachycladum* can wrap semi-solid food and liquid food. Locals widely utilize plant-based food wrappers in preparation of traditional cuisine such as the "kelupis", "ketupat", "bak chang", "nasi lemak" and "tapai". Locals also believed that wrapping food using a plant-based wrapper would make the taste of the food better and maintain the identity of the food as a traditional dish. Examples of traditional food that used plant-based food wrapper were showed in Figure 3.

The economic prospect of plant-based food wrappers in the community

According to the responses, locals believed that plant-based food wrappers had the potential to be profitable for the local economies. More than 90% of respondents concur that using food wrappers made of plants can boost the regional economy (Figure 4). This is due to the demand for the plant-based food wrapper which drives transactions with the local sellers and also the cultivation of the plants that profit the local farmers as suppliers for the market. About 98.70% of respondents were satisfied with the utilization of the plant-based food wrapper for various uses. According to Lin *et al*. (2019), using plant-based food wrappers is advantageous because they are affordable, of excellent quality, and easily accessible. For instance, *Thaumatococcus daniellii* food wrappers have a positive economic impact, notably on Southern Nigeria's rural populace (Ayodeji *et al*., 2016).

According to more than half of the survey participants, ready-made products must be created from plant-based food wrappers. In light of this, 97.7% of respondents indicated that they believe the manufacture of ready-made goods from plant-based food wrappers will be well received by the public. In addition, 90.9% of respondents think that the use of plant-based food wrappers should be widely promoted, while 9.1% are not sure if it should or not. Production of plant-based food wrappers can be very beneficial, especially to the environment as the resources used produce less carbon footprint, are biodegradable, and are easy to dispose of. These aspects can help to preserve the environment, especially dumping issues of packaging waste at the same time being value-added to the plant-based food wrapper. In addition, consumers nowadays started to become concerned about environmental issues whereby encourages production companies to consider using eco-friendly packaging when conducting their business (Wang *et al*., 2019). As the sources are biodegradable, most of the plant-based food wrappers have short shelf-life and cannot be recycled. Thus, proper handling should be implemented to avoid cross-contamination among the foods which can be harmful to humans.

From the findings documented, some plant species are typically used for personal usage, while others are employed for commercial purposes. Ten species of plants were used for commercial, nine for personal use, and two for which the function is unclear (Table 3). More than half of the respondents in this category are sellers, thus this may be relevant. Both food that is wrapped in plant-based food wrappers and plant-based food wrappers are sold by different vendors. Regarding the cost, the respondents stated that it varies depending on the selling location and is typically more expensive at the market than it is for vendors that offer plant-based food wrappers at their stalls. Additionally, while twelve of the plant species are not readily available, nine of them are. There are several plant-based food wrappers available for purchase right now. This is because it can be very challenging to get the raw materials, particularly in places like the city. Only domesticated species like banana leaves can easily be found in the city meanwhile the utilization of indigenous ones is still limited by the locals in the village area. Consumers prefer to use synthetic packaging instead of plant-based food wrappers because the packaging is more versatile, more durable, and can be recycled (Cruz *et al*., 2022). This also can be a challenge to expand the market of plant-based food wrappers.

Fig. 3. Type of traditional food that used plant-based food wrapper: (a) “nuba’ layaq”, (b) pandan chicken, (c) “pulut panggang”, (d) “tapai”, (e) “pais telur”, (f) “ketupat”, (g) “lepat ubi”, (h) “lemang”, (i) “pansuh”, (j) smoked fish and (k) “kelupis”.

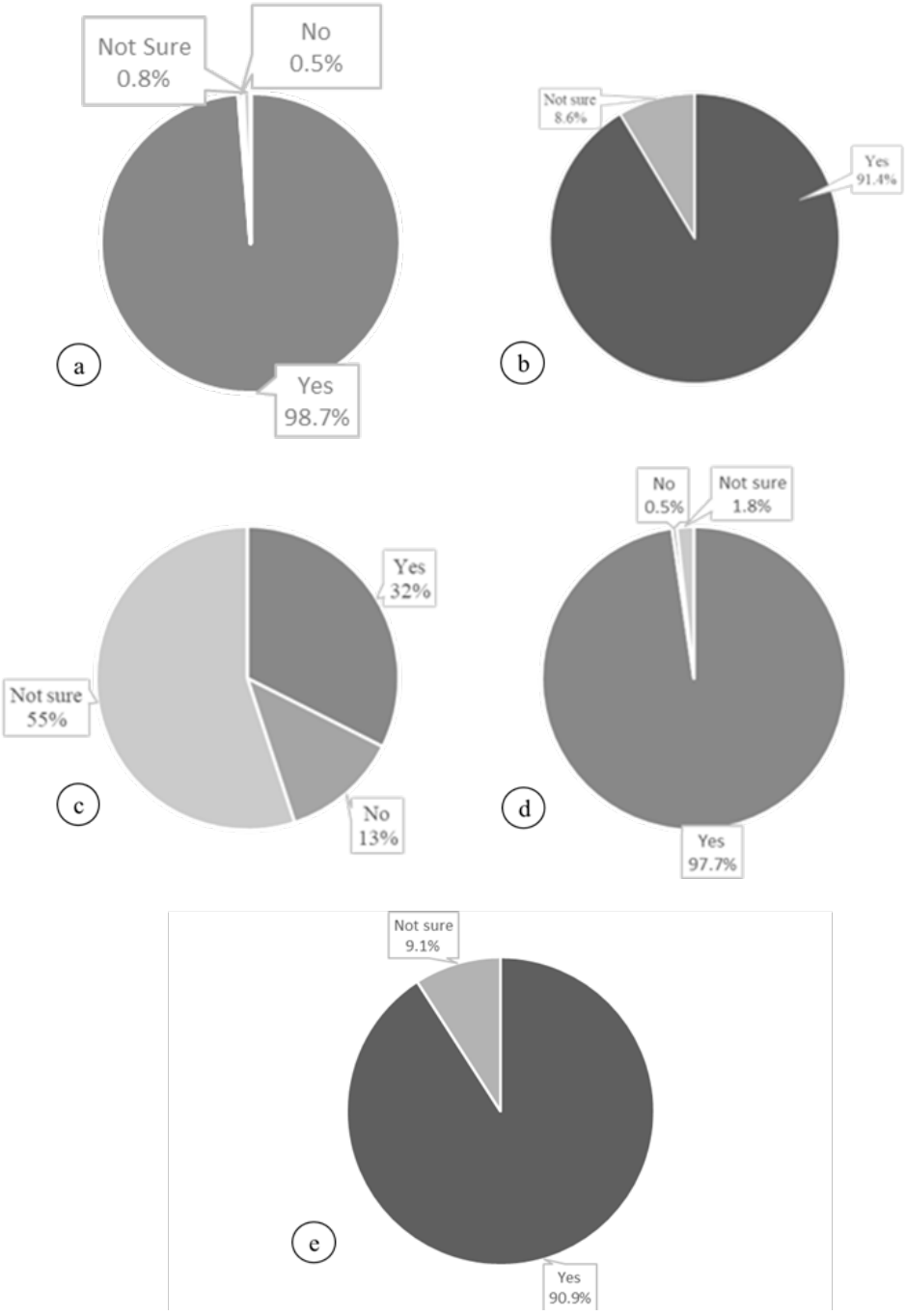

Fig. 4. Economic prospect of the plant-based food wrapper: (a) respondents' satisfaction with plant-based food wrapper usage, (b) ability of plant-based food wrapper to help the local economy, (c) ability of plant-based food wrapper to be processed into ready-made products, (d) response for ready-made products and (e) ability of plant-based food wrapper to be widely commercialized.

Table 3. The usage, and availability of the plant species in the market

Species	The purpose of the plant usage	Available in market
A. catechu	Sale	Yes
C. esculenta	Personal use	No
C. longa	Sale	Yes
C. nucifera	Sale	No
D. grandis	Personal use	No
D.suffruticosa	Personal use	No
E. guineensis	Personal use	No
I.tessellatus	Sale	Yes
L. bintuluensis	Personal use	No
L. grandis	Sale	Yes
L. petiolulata	Personal use	No
L.campestris	Personal use	No
M. bancana	Not sure	Not sure
Musa spp.	Sale	Yes
N. ampullaria	Personal use	No
N. fruticans	Sale	Yes
P. maximum	Personal use	No
P. pubinerve	Sale	Yes
P.amaryllifolius	Sale	Yes
S.brachycladum	Sale	Yes
T. catappa	Not sure	Not sure

CONCLUSION

In the current study, a total of 21 plant species used as food wrappers in Bintulu, Sarawak, have been identified. In addition, numerous application techniques that handle the steps in the production of plant-based food wrappers have been assessed including the preparation method and type of folding shape even though the plants commonly were used for wrapping the food before the cooking process. The evaluation's findings can serve as a guide for any future research projects looking to investigate this plant-based food wrapper. Future studies should also consider the nutritional composition, fiber structure, antibacterial ability, and volatile compound of the plant species to determine the precise physicochemical variations.

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ETHICAL STATEMENT

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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