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AN ETHNOBOTANICAL STUDY ON INDIGENOUS FOOD FLAVOURINGS AND AROMATIC ENHANCING PLANTS USED BY THE NATIVE COMMUNITIES OF THE CENTRAL REGION OF SARAWAK

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ABSTRACT

The uses of indigenous plants vary amongst native communities, from being consumed as vegetables, used as flavourings or added as an aromatic enhancer. However, records of their traditional use are sparse and most of the native knowledge on applications of these indigenous plants has not been passed down to later generations. The present study aims to record and identify communal knowledge from the Central Region of Sarawak with regards to the use of indigenous plants as food flavourings or aromatic enhancers. Face-to-face interviews with 150 respondents were conducted in a semi-structured manner to obtain the required information. A total of 27 plant species from 20 families were identified for their use by native people as food flavouring or aromatic enhancement. Zingiberaceae was found to be the most prevalent family of plants in this study with a representation of four species. Leaves were the part of the plants most commonly utilized by natives for flavouring purposes with 12 species being utilized in this manner. The mode of cooking varies within the community according to a preference for taste and aroma intensity as well as inherited oral knowledge passed down from older generations. This study recommends a full nutrient content analysis for the identified plant species shortly.

Key words: Food seasoning, fragrance crop, indigenous plants, native, Sarawak, traditional knowledge

INTRODUCTION

Over the centuries, plants have become an important resource to ensure the survival of humankind. Plants supply the bulk of oxygen in the atmosphere and serve a myriad of other beneficial uses to animals and humans. Plants are used as food, medicine, fibre, ornamentals, and also for numerous industrial purposes (Afolayan & Jimoh, 2009). All parts of plants such as the leaves, stems, fruits, flowers, tubers, bark, seeds, and roots are utilized by different cultures across the globe for a wide and diverse range of applications (Mishra, 2015). Human societies have a history of utilizing readily available indigenous plants for a diverse range of purposes. Indigenous plants are plant species that occur naturally within a given geographical area or were introduced to a particular region and evolved through human selection or natural processes (Phillips-Howard, 1999; van Rensburg *et al*., 2007). Indigenous plant species have contributed beneficially to local communities across the globe in economic, health and social terms (Keatinge *et al*., 2015). Indigenous plants have historically been exploited by different ethnic communities in Malaysia (Ainul Asyira *et al*., 2016). Voon and Kueh (1999) reported that Sarawak has a very rich tropical rainforest biodiversity that offers an excellent and readily available resource for rural communities. According to Ainul Asyira *et al*. (2016), rural communities show a preference to consume easily harvested indigenous plants growing wild in their vicinity. In Malaysia, indigenous plants are a daily source of nutrients, flavourings, therapy, and income (Det *et al*., 2013). In Borneo, the uses of

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indigenous plants such as *Albertisia papuana* Becc. was documented to be extensively used by the Dayak tribes of East Kalimantan (Sulvi *et al*., 2013; Purwayanti *et al*., 2013), West Kalimantan (Sulvi *et al*., 2013), and Central Kalimantan (Lusiana, 2009) as flavour enhancers due to their strong umami flavour. Getachew *et al*. (2019) also mentioned that indigenous flavouring agents are generally cheaper and safer than artificial flavourings. These findings highlighted the huge potential for indigenous plants as flavour and aroma enhancers. Flavour is a perceptual impression that is determined by the chemical sensation of the gustatory and olfactory systems (Wolfe *et al*., 2012). Schwab *et al*. (2008) and Barrett (2010) divided flavour into two aspects namely aroma and taste. In the human mouth, taste receptors sense the five taste modalities of sourness, sweetness, bitterness, saltiness and savoriness (Umami) (Trivedi & Bijal, 2012; Witt, 2019). Flavour relies on taste whereas aroma depends on the concentrations of odour-active volatile compounds (Kader, 2008; Taylor & Linforth, 2010).

Ethnobotany can be defined as studies related to the dynamic relationship between plants and people (Voeks, 2017). Ethnobotany investigates the use of plants in societies from various aspects ranging from environmental history, ecological economics and restoration, environmental ethics, and political ecology (Nolan & Turner, 2011). Ethnobotany allows the opportunity to document oral knowledge from natives through the use of both quantitative and qualitative research instruments such as interviews and surveys. Oral knowledge and traditions are passed down through word of mouth from one generation to the next (Khodja *et al*., 2020). As such, oral traditions and knowledge need to be recorded and preserved to ensure that they are not lost over time.

Sarawak has an equatorial climate and is rich in tropical rainforests abundant with both animal and plant species (Trudy *et al*., 2012). There have been prior ethnobotanical studies in Sarawak but most have focussed on the use of indigenous plants for direct consumption (Voon & Kueh, 1999; Shaffiq *et al*., 2013; Ainul Asyira *et al*., 2016; Saupi *et al*., 2020; Saupi *et al*., 2021). There is still a lack of research with regards to the traditional knowledge of plant usage as flavourings or aroma enhancers. Thus, the present study was conducted to investigate and document the use of indigenous plant species by native communities in Sarawak's Central region as food additives for flavouring and aroma enhancement.

MATERIALS AND METHODS

Study site

Sarawak is the largest state in Malaysia with an area of 124, 450 km$^{2.}$ Sarawak lies between 0° 50' and 5°N latitude and 109° 36' and 115° 40' E longitude, approximately north of the Equator. Sarawak's state boundaries extend 800 km along Borneo's northwest coast. It is located on the island of Borneo and is bordered by Sabah, Kalimantan, and Brunei. Sarawak is divided into three regions; Southern, Central, and Northern consisting of 12 divisions. This study was conducted in the Central region of Sarawak which comprises four divisions namely; Sibu, Bintulu, Kapit, and Mukah (Figure 1). The Central region of Sarawak covers an area of 66, 376.11 km^2 which is approximately 54% of the total land area of the state. The study was conducted around local farmers markets ("Tamu") and various native settlements.

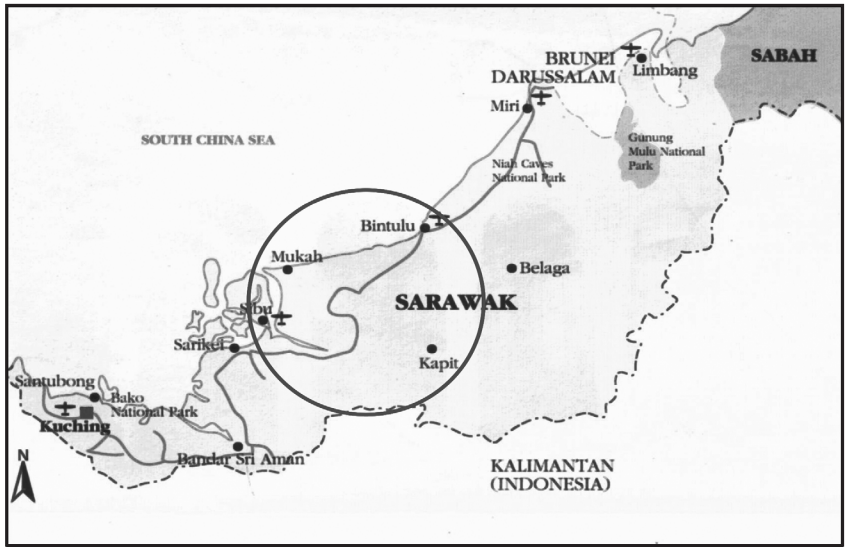

Fig. 1. Location of the study area.

Data collection

Local farmers markets ("Tamu") and native settlement areas were selected as the main locations for conducting field surveys. 150 respondents participated in the present study. A Key Respondent Survey was carried out on each of the study respondents. Information was collected based on respondents' answers to the survey questionnaire. Questionnaires were written bilingually in English and Malay to aid with respondents understanding of the questions. Questionnaires consisted of three sections namely; personal information, basic information on the potential of plant species as food flavourings or aroma enhancers. Field surveys were conducted during the weekends for a period stretching between December 2020 to February 2021. Questionnaires were distributed in local market areas from 8 am to 12 noon during survey days. Weekends were selected due to the higher number of visitors in comparison to weekdays. In native settlement areas featured in this study, the questionnaire was distributed to any available residents within the vicinity. Each respondent was briefed before filling out the questionnaire. Sampling was carried out using a simple random sampling method to ensure an unbiased representation of the community. This method ensures an equal probability of any member of the statistical population to be chosen for the survey. Throughout each interview, a rapid appraisal method using semi-structured questionnaires was conducted to compile relevant and accurate information on plant samples. Demographically, respondents were aged between 15 to 75 years old. Questionnaires were answered according to the knowledge of the respondents. The interview section aimed to collect information from respondents on (i) local name, (ii) habitat, (iii) uses, (iv) plant parts used, (v) taste or aroma, (vi) method of consumption, and (vii) cooking methods. Illiterate respondents were assisted by the interviewers to fill in the survey forms. The local name of the plants, plant parts, and their applications was obtained from information collected in the survey forms. The first stage of species identification of the indigenous plants used was conducted immediately after the survey with assistance from the survey respondents via a transect survey and a brief interview session. Then, a thorough identification of plant species was conducted by identifying the morphology of the species based on the plant data bank and description based on Jansen (1993), Det *et al*. (2013), Ismail (2000) and Rukayah (2000).

Data analysis

The utilization of plants as food flavourings or aromatic enhancers was analysed using the Statistical Package for Social Science (SPSS), *IBM* ®V22.0 Software. Data were analysed descriptively to show frequency.

RESULTS AND DISCUSSION

Demography of respondents

Communities from the areas of Sibu, Kapit and Mukah participated in the survey. In terms of gender, 73.47% were female and 26.53% were male (Figure 2). There were approximately three times more female respondents than males. 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 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). Mishra *et al*. (2015) explained that women are responsible for their household's diet which necessitates them to be informed on plant identification and uses. A total of 59.18% of respondents resided in suburban areas and 40.82% in rural areas (Figure 2). According to Cunningham (1994), those residing in more remote areas with easier access to natural resources usually have a higher awareness of traditional knowledge in comparison to those living in suburban and urban areas.

In terms of age, 46.94% of the respondents were aged from 31 to 59 years old, 42.86% of informants were above 60 years old and 10.20% of the study respondents were between 15 to 30 years old (Figure 2). Traditional knowledge is normally passed down from one generation to the next. The present study targeted respondents from the middle-aged to elderly demographic. Dixit and Goyal (2011) mentioned that elders are often viewed as a valuable national resource with adaptable and useful inter-generational oral information. In most cases, those belonging to the younger generation do not have adequate traditional knowledge. The younger generation tend to rely more on artificial sources and refuse to participate in practising traditional knowledge (Md. Sharif *et al*., 2013).

Diversity of food flavouring and aromatic plants

27 species of plants from 20 families were identified in the present study. Zingiberaceae had the highest number of taxa represented with four species. Zingiberaceae or commonly known as the ginger family is a family of pantropical herbs which are abundant in lowland tropical rainforests of the Malesian region; around 112 species can be found in Borneo (Mohamad & Kalu, 2018; Mohamad *et al*., 2020). Natta *et al*. (2008) observed that Zingiberaceae was among the many useful plant species found in Southeast Asia. Plants in the Zingiberaceae family

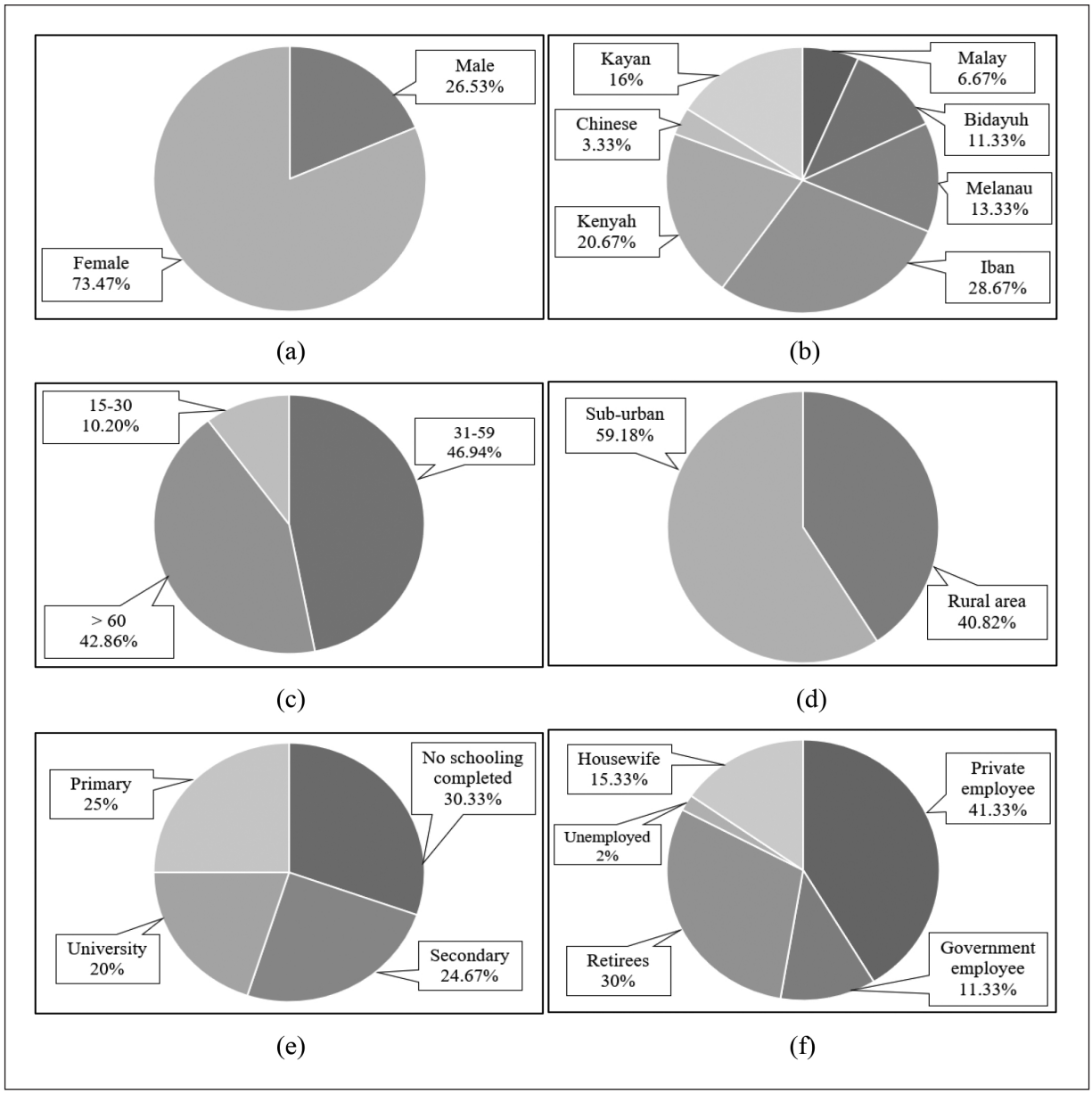

Fig. 2. Data set of respondents (a) gender of respondents; (b) ethnicity of respondents; (c) age of respondents; (d) living area of respondents; (e) education level of respondents; (f) occupation of respondents.

are known to possess antibacterial and antifungal properties, also species in this family are often used as food seasoning (Natta *et al*., 2008; Chua, 2008; Pintatum *et al*., 2020). The families of Clusiaceae, Menispermaceae, Poaceae, and Rutaceae had two representative species for each family. 15 other plant families identified were: Achariaceae, Amaryllidaceae, Arecaceae, Bromeliaceae, Cucurbitaceae, Dilleniaceae, Fabaceae, Lamiaceae, Marantaceae, Myrtaceae, Olacaceae, Pandanaceae, Piperaceae, Polygonaceae, and Solanaceae each represented by a single species.

The dominant part of the plant used for flavouring or aromatic effect was the leaves (Figure 3). Leaves of *Allium tuberosum, Dillenia suffruticosa, Murraya koenigii, Pandanus odorus, Pangium edule, Persicaria odorata, Phacelophrynium maximum, Premna cordifolia, Pycnarrhena tumefacta, Scorodocarpus borneensis, Syzgium polyanthum,* and *Tiliacora traindra* were found to be utilized by people of the Sarawak Central Region as flavourings or aromatic enhancer. This was followed by fruit (7 species), plant stem (2 species), rhizome (2 species), flower (1 species), berry (1 species), seed (1 species), stalk (1 species), and pith (1 species). Aromatic and flavour compounds are biosynthesized in different plant parts such as the leaves, fruits, flowers, and roots (Schwab *et al*., 2008; Getachew *et al*., 2019).

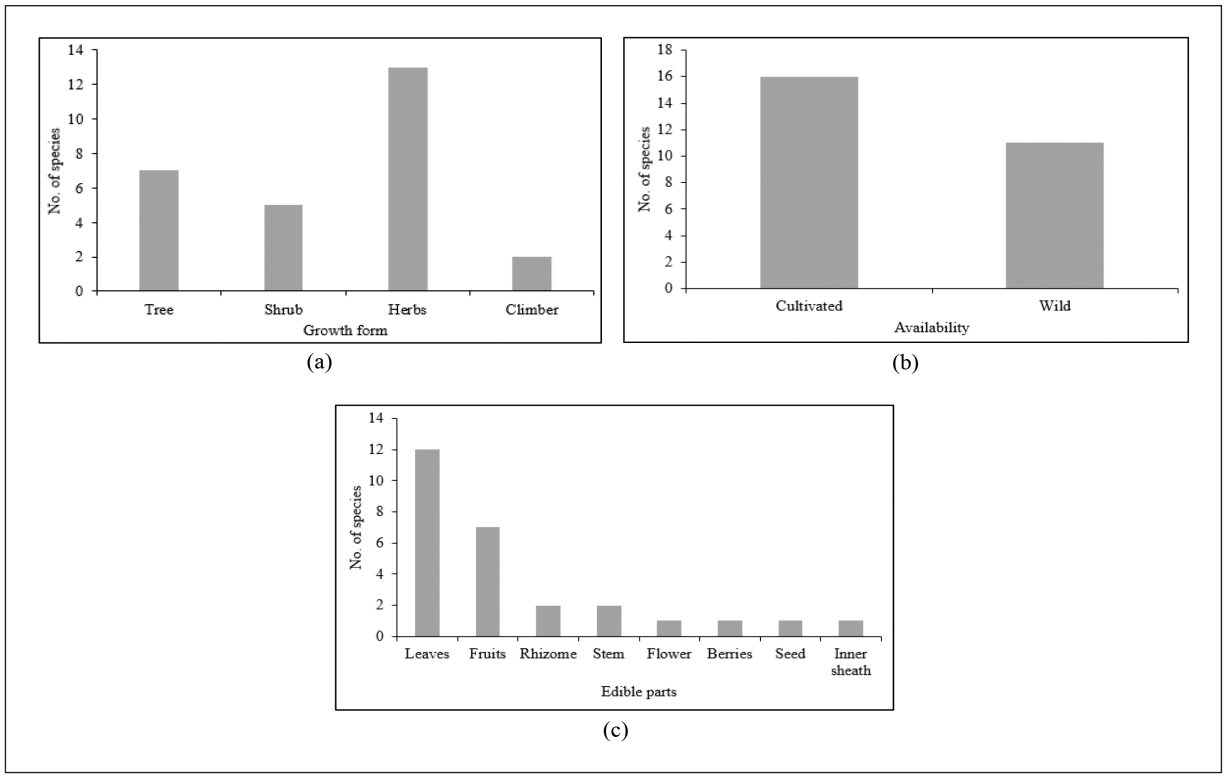

Fig. 3. Data set of plant diversity (a) growth form of the plants; (b) availability of the plants; (c) edible parts of the plants.

The plant species identified in the present study could be categorized into several forms such as trees, shrubs, palms, herbs, and climbers (Figure 3). Thirteen species identified in the present study were categorized into the herb forms; *Alpinia galanga, Allium tuberosum, Ananas comosus, Cymbopogon citratus, Cymbopogon nardus, Eleiodoxa conferta, Etlingera coccinea, Etlingera elatior, Momordica charantia, Pandanus odorus, Persicaria odorata*, *Phacelophrynium maximum,* and *Zingiber officinale*. Seven species were categorized into the tree form; *Dillenia suffruticosa, Garcinia forbesii, Garcinia xanthochymus, Pangium edule, Parkia speciosa, Scorodocarpus borneensis,* and *Syzgium polyanthum*. Five species were categorized as shrubs *Citrus aurantifolia, Murraya koenigii, Premna cordifolia, Pycnarrhena tumefacta,* and *Solanum lasiocarpum*. Only two species of plants identified in the present study were categorized into the climber form: *Piper nigrum* and *Tiliacora triandra*.

Mode of consumption

This investigation documented 11 species of plants used as flavourings and seasonings, 11 species used for aromatic or fragrance enhancement purposes, and five species that were used either for flavouring or aroma enhancing purposes (Table 2). The communities surveyed in this study utilized *G. forbesii* and *T. triandra* by cooking them in fish soup to introduce a sour taste and offset the off-flavours of freshwater fish. *Pangium edule* was added to the meats or other vegetables during the making of a local fermented dish called 'pekasam', due to its ability to eliminate rancid odours and prevent food spoilage (Figure 5). *Pycnarrhena tumefacta, S. borneensis*, and *Syzgium polyanthum* were used as food seasonings. Mohammed *et al*. (2019) reported that *P. tumefacta* possesses a savoury umami taste which is commonly used to enhance food by the Iban, Kenyah, Kayan, Bidayuh, and Kelabit ethnic groups in Sarawak. *Scorodocarpus borneensis* possesses a strong and pungent odour similar to garlic, leading to its use as a substitute for garlic by natives (Chai, 2000). *Dillenia suffruticosa* and *P. maximum* leaves are used to wrap glutinous rice traditional dish known as 'nubaq layaq'. *Etlingera coccinea* is commonly used as a marinade for fish, chicken, and pork in a local bamboo cooked dish called 'pansuh' (Figure 6).

CONCLUSION

Twenty-seven species of plants were identified for their use as flavouring and aroma enhancers by natives of the Sarawak Central Region. Each of the

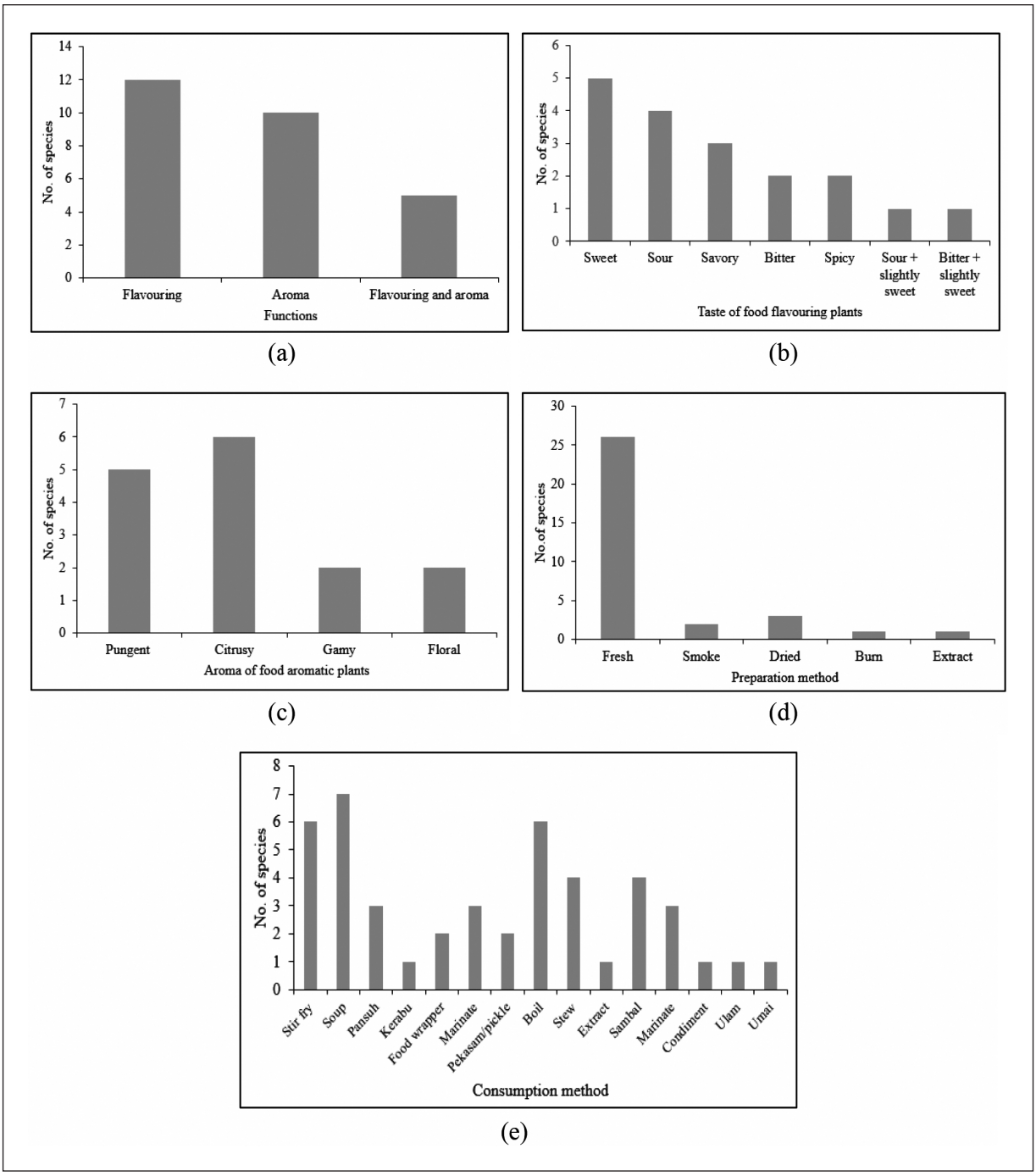

Fig. 4. Data set of plant consumption modes (a) functions of plants;(b) taste of food flavouring plants; (c) aroma of food aromatic plants; (d) preparation method; (e) consumption method.

species identified possessed unique characteristics to enhance dishes leading to various consumption methods. Leaves were the dominant part of the plant used for this purpose, followed by fruits, stem, rhizome, pith, berries, and flowers. Documentation of traditional knowledge on plants is essential to preserve this oral tradition for future generations. It is hoped that the present study will lead to further research into this subject matter, particularly in regards to the phytochemical aspects such as odour-active volatile compounds of the plants identified here. This research can be a strong motivator for the state to develop its natural products while introducing the many beneficial indigenous plants of Sarawak to the world.

Table 1. The description of the plants used as food flavouring and aroma

No.	Scientific name	Family	Local name	Plant parts	Availability
1.	*Allium tuberosum* Rottler ex Spreng.	Amaryllidaceae	Kucai	Leaves	Cultivated
2.	*Alpinia galanga* (L.) Willd.	Zingiberaceae	Lengkuas	Rhizome	Cultivated
3.	*Ananas comosus* (L.) Merr.	Bromeliaceae	Pineapple	Fruits (Flesh)	Cultivated
4.	*Citrus aurantifolia* (Christm.) Swingle	Rutaceae	Limau nipis	Fruits (Flesh)	Cultivated
5.	*Cymbopogon citratus* (DC.) Stapf.	Poaceae	Serai makan	Stem (Tiller)	Cultivated
6.	*Cymbopogon nardus* (L.) Rendle	Poaceae	Serai wangi	Stem (Tiller)	Cultivated
7.	*Dillenia suffruticosa* (Griff ex Hook.f. & Thomson) Martelli	Dilleniaceae	Buan	Young and mature leaves (Blade only)	Wild
8.	*Eleiodoxa conferta* (Griff.) Burret	Arecaceae	Asam paya / asam kelubi / maram	Fruits (Mesocarp)	Cultivated
9.	*Etlingera coccinea* (Blume) S. Sakai & Nagam	Zingiberaceae	Tepus	Leaves (Pith)	Wild
10.	*Etlingera elatior* (Jack) R.M.Sm.	Zingiberaceae	Kantan/kechalak	Flower	Cultivated
11.	*Garcinia forbesii* King.	Clusiaceae	Kundung	Fruits (Pericarp)	Wild
12.	*Garcinia xanthochymus* Hook.f.ex. T. Anderson	Clusiaceae	Kandis	Fruits (Pericarp)	Wild
13.	*Momordica charantia* L.	Cucurbitaceae	Bitter gourd	Fruits (Pericarp)	Cultivated
14.	*Murraya koenigii* (L.) Sprengel	Rutaceae	Kari	Young and mature leaves (Blade with petiole)	Cultivated
15.	*Pandanus odorus* Ridl.	Pandanaceae	Pandan	Young and mature leaves (Blade only)	Cultivated
16.	*Pangium edule* Reinw.	Achariaceae	Kepayang	Young leaves (Blade with petiole)	Cultivated
17.	*Parkia speciosa* Hassk.	Fabaceae	Petai	Seeds	Wild
18.	*Persicaria odorata* (Lour.) Sojak	Polygonaceae	Kesum	Young leaves (Blade with petiole)	Cultivated
19.	*Phacelophrynium maximum* (Blume) K.Schum.	Marantaceae	Lung / isip / itip	Young leaves (Blade with petiole)	Wild
20.	*Piper nigrum* L.	Piperaceae	Lada	Berries	Cultivated
21.	*Premna cordifolia* Roxb.	Lamiaceae	Singkil / buas	Young leaves (Blade only)	Wild
22.	*Pycnarrhena tumefacta* Miers.	Menispermaceae	Tubu	Young leaves (Blade with petiole)	Wild
23.	*Scorodocarpus borneensis* Becc.	Olacaceae	Kesinduk	Young leaves (Blade only)	Wild
24.	*Solanum lasiocarpum* Dunal.	Solanaceae	Terung Dayak / terung asam	Fruits (Mesocarp)	Cultivated
25.	*Syzygium polyanthum* (Wight) Walp.	Myrtaceae	Bungkang	Young leaves (Blade with petiole)	Wild
26.	*Tiliacora triandra* (Colebr.) Diels	Menispermaceae	Kancam	Young leaves (Blade only)	Wild
27.	*Zingiber officinale* Roscoe.	Zingiberaceae	Halia	Rhizome	Cultivated

Table 2. Description of consumption method for the food flavouring and aroma enhancer plants

No.	Scientific name	Purpose	Taste/aroma	Preparation method	Consumption method
1.	*Allium tuberosum*	Flavouring	Sweet	Fresh	The leaves are chopped and stir-fried with onion, garlic, and anchovies.
2.	*Alpinia galanga*	Aroma	Pungent smell	Fresh	The rhizomes are pound and mixed with meats for 'pansuh' dishes, meat cooked in bamboo along various spices. Blend the rhizome with onion, lemongrass, chillies, garlic, and cook together with anchovies, shrimp paste, and tamarind as 'sambal'.
3.	*Ananas comosus*	Flavouring	Sour with slightly sweet	Fresh	The juice is added to dishes to introduce a sour taste.
4.	*Citrus aurantifolia*	Flavouring and aroma	Sour and citrus smell	Fresh	Juice is added to a local dish with onion, chillies and raw fish called 'umai'.
5.	*Cymbopogon citratus*	Aroma	Citrusy smell	Fresh	The tillers are pounded and cooked together with chicken, meat, or fish.
6.	*Cymbopogon nardus*	Aroma	Citrusy smell	Fresh	The tillers are pounded and cooked together with chicken, meat, or fish.
7.	*Dillenia suffruticosa*	Aroma	Gamy smell	Fresh	The leaves are used to wrap the glutinous rice.
8.	*Eleiodoxa conferta*	Flavouring	Sour	Fresh	The flesh is used for pickling and also use as a substitute for tamarind. The flesh is chopped and cooked with chilli paste, anchovies, garlic, and onion as 'sambal'
9.	*Etlingera coccinea*	Aroma	Pungent smell	Fresh	The pith is chopped and stir-fried together with chillies, onion, garlic, and anchovies. The pith is mixed together during the marination of meat for 'pansuh'.
10.	*Etlingera elatior*	Aroma	Pungent smell	Fresh	The flower is chopped finely and combined with lime, anchovies or fish, onion, and chillies for the 'kerabu' dish. The flower is cut in half and put into the 'asam pedas' dish or 'pansuh'. The flower is chopped finely and stir fry with shrimp paste, onion, anchovies and chillies.
11.	*Garcinia forbesii*	Flavouring and aroma	Sour with the citrusy smell	Fresh or smoked	The rind was separated from the flesh and was then smoked and cooked together in fish soup. Introduce sour taste in dishes.
12.	*Garcinia xanthochymus*	Flavouring and aroma	The sour and citrusy smell	Fresh or smoked	The rind was separated from the flesh and was then smoked and cooked together in fish soup. Introduce sour taste in dishes.
13.	*Momordica charantia*	Flavouring	Bitter	Fresh	Stir-fried together with onion, garlic and eggs.
14.	*Murraya koenigii*	Flavouring and aroma	Savoury and pungent smell	Fresh or dried	The leaves are stewed together with curry paste and coconut milk.
15.	*Pandaus odorus*	Aroma	Floral smell	Fresh or extract	The leaves were washed, tied and boiled for 15 minutes to get the extract for making dessert.

Table 2 continued...

16.	*Pangium edule*	Aroma	Bitter	Fresh or dried	The young leaves were chopped and fermented with fish or meat as 'pekasam'.
17.	*Parkia speciosa*	Flavouring	Bitter with slightly sweet	Fresh	Cooked together with chilli paste, onion, garlic and tamarind as 'sambal'. Stewed together with pounded cassava leaf, coconut milk, turmeric, and 'tempoyak'. Eaten raw as 'ulam'.
18.	*Persicaria odorata*	Flavouring and aroma	Savoury and pungent smell	Fresh	Leaves were washed and stewed together with fish in sour spicy gravy. Cooked together with other ingredients in a 'pansuh' dish.
19.	*Phacelophyrynium maximum*	Aroma	Gamy smell	Fresh	The leaves were used to wrap the mashed rice called 'nubaq layaq'.
20.	*Piper nigrum*	Flavouring	Spicy	Dried	The dried berries were crushed and added inside the soup or any dishes (black pepper). The pericarp was removed. Dried peppercorns were crushed and added inside the soup or any dishes (white pepper).
21.	*Premna cordifolia*	Flavouring	Sweet	Fresh	Leaves were chopped and stir-fried with bamboo shoots or anchovies. Leaves are chopped finely and cooked together with other ingredients as 'bubur pedas' Stewed together with onion, garlic, anchovies and coconut milk.
22.	*Pycnarrhena tumefacta*	Flavouring	Savoury	Fresh	The leaves are chopped finely and cooked together inside the dishes.
23.	*Scorodocarpus borneensis*	Flavouring	Sweet	Fresh	Stir-fried with onion, chillies, and garlic for fish or chicken dishes also for soup dishes.
24.	*Solanum lasiocarpum*	Flavouring	Sour	Fresh or burn	The flesh was cut and boiled inside the soup. Burn the fruits, remove the burnt exocarp, chop the fruit into small pieces and mix with crushed chillies, and salt. Stir-fry the flesh with shrimp paste, onion, garlic, and smoked fish.
25.	*Syzygium polyanthum*	Flavouring	Savoury	Fresh	Added into soup or 'pansuh' as seasoning.
26.	*Tiliacora triandra*	Aroma	Pungent smell	Fresh	The leaves were washed and added to fish soup. Mixed during marination of meat or fish for 'pansuh'.
27.	*Zingiber officinale*	Flavouring and aroma	The slightly spicy and citrusy smell	Fresh	Cut or pound the rhizome and mix during marination for 'pansuh'. The rhizome is finely chopped and boiled together in fish or chicken soup.

Fig. 5. *Pangium edule* in a local fermented food called 'pekasam'.

Fig. 6. *Etlingera coccinea* in a local dish called 'pansuh'.

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