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The aim of this study is to identify the non-woody plants that are utilized by local communities in Papua Island, Indonesia for food and beverages. Results of the study will provide baseline information for the local Government to develop management strategies and policies for the conservation of the forest resources, including the useful plants. The data was gathered through observation, interviews and focused group discussion with people which is strongly influenced in the communities. Data gathered included indigenous knowledge of plant use and others indigenous practices and perceptions pertaining to the use and management of the forest. There are 90 plant species belonging to 38 families that where identified that are used by the local communities primarily for food and beverages. Of which, 21 species that belong to Arecaceae are frequently used by the local communities. The plant parts utilized are usually the fruits and leaves.

Keywords: Non timber forest products, Food and beverages, Forest vegetation, Indigenous knowledge
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Indonesia is one of the mega-biodiverse countries[1]. It has approximately 120.4 million hectares of forest land and it knows worldwide as the largest tropical forest with a high degree of biodiversity. The forests are important in providing and sustaining the needs of the present and future generations. For the past decades, forest and agriculture sectors have been the main source of income[2-3], this had a positive effect on the foreign exchange earnings, national development and regional economic growth. In other countries, Ziaie *et al*,[4] reported that more than 77% of the Malaysian woody furniture products are being exported thus making them rank ninth in the global market or second in the Asia. Indonesia had also contributed to the export of pulp and paper with value of US$706.8 million and US$ 363 million for all sawn wood[5]. The rubber industry has brought Indonesia one of the largest exporting countries in 2008 with production of 2.7 million ton[6].

The degree of dependency of people on their natural environment can be definied by geographic location, accesibility and technology. People who live in the remote and isolated villages depend largely on the agricultural crops that they cultivate and other commodities that are produced from raw materials that are gathered from the environment. Conversely, the community in north eastern Tarai District, India are dependent on medicinal plant in curing different diseases[7], similarly, the local people of southwestern Nigeria primarily depend on two plant species for their nutrition needs, namely *Corchorus olitorus* and *Celosia argentina* which are consumed as vegetables[8]. These two species are also economically valued.

Forest are potential source of economically important plants and other resources. It was estimated that in the course of time and on a worldwide scale, 1500-2000 plant species that are found in the forest have been used as supplementary food. In terms of floristic richness, forest in Indonesia ranks fifth in the world and contains more than 38,000 plant species[9]. In South-East Asia, the number of plant species is close to 1000 species[10]. According to Mirjam *et al.*[11], plant species used as non-woody plants has been estimated to be about 575 species. In Papua, Womersley[12] reports that its forests have 20,000 – 25,000 vascular plants, of which about 60% to 90% of the plants in this region are endemic[13].

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Papua contributes 32.8% of the total land area of Indonesia forest[14]. The history of forest resource utilization in Papua is as old as the age of Papuan human civilization from primitive livestyle to the different stages such as hunter gatherer, shifting cultivation, peasant community to the modern stage. The life of the people during each stage was sustained by the resources that were gathered from the forest. The utilization of forest resources for food has been recorded in ethnobotanical studies. Accoeding to Powell[15], ethnobotanical uses of forest resources in Papua include food, construction, fuel, medicine, furniture, art and many others. As many as 229 species of plants were identified by Powell[15] that are used as food for the entire Papua Island. Some of the important food plants are *Metroxylon* spp, *Musa* spp and *Pandanus* spp. Many plant parts are used including nuts.

With the richness of the forests, this study aim to identify the different plants in the forests that are used by the local community. This study will also focus on how the plants that are found in the forests are used and how this indigenous in handed down from generation to generation.

Materials and methods

The Study area

The study area covers several villages in Papua island (Fig. 1). The study particularly focused on village people who depend their everyday sustenance on the forest. The villages are located in different topography with a wide range of ecosystems (Table 1). People was being informant deliberately chosen and taking into account their status in the hierarchy of cultures and how often interacted with forest for meets their basic needs. The number of informants taken as much as 15-20 percent of the total population sample for each experimental location. From the survey, shown that average number of people in a community in each location ranged roughly between 100-300 people or as much as 25 to 35 households.

Data collection

This reseach uses descriptive method by direct field observation and semi-structural interview[16] which are intended to indentify local community who obtaining plant-based food from their surrounding forest. Materials used i.e. interviewing instrument (Questionnaire) to obtain comprehensive information related to the use of forest and also paperwork equipment to record the responses given. Each informant was given same question based on questionnaire cover kinds and types of vegetation, part of plant that utilized (fruit, leaves, tuber, pith, rhizome, seed and stem) and how to process until ready to eat. and further interviews were collected and analysed by looking at the dominant response by scoring process as a representation of indigenous people in selecting forest resources. while for plant identification purposes used plant identification person (taxonomical expert) to identify forest vegetation species which utilized.

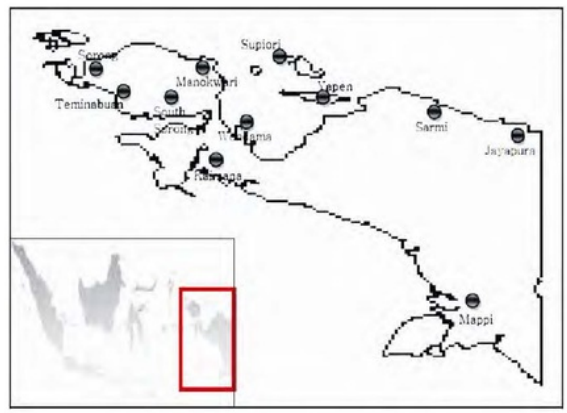

Fig. 1—Map of distribution of plant species utilized

Table 1—Number of regency, tribe and geographycal information from the sample site

No.	Regency/ District	Position	Range of Altitude	Tribe
1	Mappi	Southern part	0-100 mdpl	*Yachay*
2	Jayapura	Northern part	10-100 mdpl	*Sentani*
3	Sarmi	Northern part	0-500 mdpl	*Armati*
4	Yapen	Northern part	0-800 mdpl	*Yapen*
5	Supiori	Northern part	0-700 mdpl	*Sowek*
6	Kaimana	Western part	0-800 mdpl	*Irarutu*
7	Wondama	Western part	0-300 mdpl	*Wamesa*
8	Manokwari	Western part	500-1500 mdpl	*Mandacan*
9	Sorong	Western part	0-500 mdpl	*Mooi*
10	South-Sorong	Western part	5-50 mdpl	*Ayamaru*
11	Teminabuan	Western part	3-10 mdp	*Teminabuan*

Results

Edible plants

Relatively, edible plants species cover seedy plant group (Spermathopytha), *talus*/fungi (Thalophyta) and edible fern (Pteridophyta). Group of seedy plants consisting of both monochotyledonae encompass of 11 families, 33 species and dicotyledonae about 19 families, 45 species yet for low level groups such as Thalophyta covers only 5 families and 7 species and pteridophyta was the lowest point of 3 families and 7 species. Fig. 1 show the number of plant eats by indigenous people all over the Papua Island.

If compared with the total number of species which is highly frequent used point out that monocotyledonae constitutes the highest of forest vegetation comes from *Arecaceae* group reached 21 species used then followed by Pteridophyta group with 11 species and Zingiberales, Thalophyta and Poaceae by 9 species, respectively.

Vegetation used

Part of vegetation which is used as a source of food by people in Papua showed very different value. The pattern of use also depends on each region and their culture. Commonly part of vegetation which always be used roughly consisted of rhizome, stem, pith, leaves, tuber, seed, bamboo shoot, fruit and sheath of leaf. The investigation has found that most people, who directly depend on forests for their lives, used and consumed it in all parts.

Staple and additional food

Primary food is a group of edible plant from forest vegetation that contained lots of carbohydrate and in the local lifestyle which has available to consume. In contrary, secondary food is a group of edible plat from forest vegetation that contained lots protein, grease and other componens for establishing human body[17]. From Table 2, classified in to two categories of plant species that are staple food which is describes the frequency of utilization of the plant that is continuous taken and being crucial component in meets the needs of food for a particular community tribe. Additional food is classified as functional food that meets and serves as a supplementary food. These components usually consist of vegetables.

Discussion

Utilization of Non Timber Forest Products (Vegetable) in Papua

Forest and agriculture sectors were generally provided lots benefit and it utilization has long been seen all over the world for meet a demand human being life in both directly and indirectly ways[18,3]. Most rural communities is always hunging up their life on the forest due to it able to serve their necessity. This also applies in Papua in which majority of their livelihood was closely integrated by the plants and animal life. Their predecessors depended upon the richness of the forest, oceans and rivers for their daily food, clothing, building materials, tools, weapons and medicine[12].

Many ways traditionally has been show regarding forest utilization by papuan community, for examples getting salt in Yali tribe, one of the highland tribes in Papua island. It was become a highly desirable and valuable commodity for them as for it has many other functions that just regulating the water content of the body. So as to meet they needs of salt, they extract directly ashes from certain types of salt-rich plant to produce salt then it used for cooking[19]. That tribe also produced string bags (*sum*) used to carry food are an important part of Yali technology designed from forest products and serve several other purposes. They are made of bark fibre (*hekel*) which is stripped from the twigs of a variety of tree and shrub species (mainly of the family Urticaceae) and rolled into a strong three-ply cord on the thigh. Regular cutting of the same bushes encourages coppice-type growth, producing suitably long and narrow twigs. The string is woven into bags of varying sizes using *Pandanus* leaf spacers to keep the mesh size regular.

Edible plants

The vegetation of New Guinea is extremely diverse with many different plant communities occupying the varied terrain from coastal flats to high mountain slopes[20]. Reseach concerning the usage of non timber forest products vegetation which proccessed for food in some areals in Papua indicating highly various species. Based on investigate revealed that there are around ninety-two (92) species from thirty-eight (38) families that has been used in fulfilling their life particularly for food and beverages. Those species has represented about a third of edible wild plants species throughout India with 286 that belongs to 93 families[3].

Vegetation that used as edible plant sources scattered across wide range of growth areas as well as forest vegetation types in several classifications such as low land forest, swamp forest, savanna, water

Table 2— Plants used by the different local communities in Papua Island for food and beverages

Plant species	Local name	Family	Food classification	Plant parts used
Staple food				
Metroxylon sagoo	*Wariang*	Arecaceae	Main food	Inner trunk/extract
Bruguiera gymnorrhiza	*Arouw*	Rhyzoporaceae	Viand	Fruit/cooked
Heritiera littoralis	*Wai paramay*	Malvaceae	Viand	Fruit/cooked
Soneratia alba	*Wararekay*	Soneratiaceae	Viand	Fruit/cooked
Soneratia ovate	*Pampami*	Soneratiaceae	Viand	Fruit/cooked
Nypa fruticans	*Wamboy*	Arecaceae	Main food/Viand	Fruit/cooked
Additional food				
Bambusa vulgaris	*Sua*	Poaceae	Vegetable	Shoot/cooked
Bambusa ventricosa	*Manana*	Poaceae	Vegetable	Shoot/cooked
Bambusa bambos	*Takaketuy*	Poaceae	Vegetable	Shoot/cooked
Bambusa blumeana	*Mampenasi*	Poaceae	Vegetable	Shoot/cooked
Neololeba atra	*Namurang*	Poaceae	Vegetable	Shoot/cooked
Schisostachyum brachyclaudum	*Hampe*	Poaceae	Vegetable	Shoot/cooked
Schizostachyum copelandi	*Mamurang*	Poaceae	Vegetable	Shoot/cooked
Schizostachyum serpentium	*Kayari rawang*	Poaceae	Vegetable	Shoot/cooked
Schizostachyum lima	*Kawuwu rawing*	Poaceae	Vegetable	Shoot/cooked
Pteridophyta				
Diplasium esculentum	*Rampiaya*	Athyriaceae	Vegetable	Leaves/cooked
Diplasium dietrichianum	*Awo bong*	Athyriaceae	Vegetable	Leaves/cooked
Diplasium sibiricum	*Andoring*	Athyriaceae	Vegetable	Leaves/cooked
Diplasium melanochlamys	*Karawery*	Athyriaceae	Vegetable	Leaves/cooked
Stenoclaina palustris	*Werang*	Blechnaceae	Vegetable	Leaves/cooked
Stenoclaina hainanensis	*Takaketuy*	Blechnaceae		
Nephrolepis bisserate	*Mapenansi*	Dryopteridaceae	Vegetable	Leaves/cooked
Dryopteris rufescens	*Mancewa*	Dryopteridaceae	Vegetable	Leaves/cooked
Dryopteris goldiana	*Surundany*	Dryopteridaceae	Vegetable	Leaves/cooked
Dryopteris hirtipes	*Rakinaki*	Dryopteridaceae	Vegetable	Leaves/cooked
Dryopteris filix	*Andau*	Dryopteridaceae	Vegetable	Leaves/cooked
Thalophyta				
Lentinus tigrinus	*Kiromaing*	Polyporaceae	Vegetable	All parts
Pleurotus djamor	*Aimungkang*	Pleurotaceae	Vegetable	All parts
Pleurotus pulmonarius	*Dang*	Pleurotaceae	Vegetable	All parts
Pleurotus polulinus	*Marapa*	Pleurotaceae	Vegetable	All parts
Volvaria volvacea	*Ampate*	Pluteaceae	Vegetable	All parts
Auricularia polytrica	*Timbur*	Auriculariaceae	Vegetable	All parts
Cyptotrama asprata	*Paringkeng*	Physalacriaceae	Vegetable	All parts
Crytotrame chrysopeplum	*Kiriboromi*	Physalacriaceae	Vegetable	All parts
Clavariaceae	*Rasyoi*	Clavariaceae	Vegetable	All parts
Zyngiberales				
Curcuma longa	*Kawey*	Zingiberaceae	Spice	Rhizome
Curcuma zedoaria	*Wawa*	Zingiberaceae	Spice	Rhizome
Curcuma aromatica	*Amakupi*	Zingiberaceae	Spice	Rhizome
Alpinia serumbet	*Rausasung*	Zingiberaceae	Spice	Rhizome
Alpinia speciosa	*Sumsayrani*	Zingiberaceae	Spice	Rhizome
Alpinia nutans	*Kariboy*	Zingiberaceae	Spice	Rhizome
Etlingera elatior	*Anawery*	Zingiberaceae	Spice	Rhizome
Hornstedtia scottiana	*Kamana*	Zingiberaceae	Spice	Rhizome
Hornstedtia scyphyfera	*Dangkakopay*	Zingiberaceae	Spice	Rhizome

Contd

Table 2— Plants used by the different local communities in Papua Island for food and beverages:— *Contd*

Plant species	Local name	Family	Food classification	Plant parts used
Arecaceae				
Arenga microcacarpa	*Awey werang*	Arecaceae	Vegetable	Green leaves
Arenga glandiformis	*Manyeru*	Arecaceae	Vegetable	Green leaves
Areca parens	*Warimuki*	Arecaceae	Vegetable	Green leaves
Calamus aruensis	*Karipiapa*	Arecaceae	Water/beverages	Stem
Calamus tenuis	*Karuh*	Arecaceae	Water/beverages	Stem
Caryota rhumpiana	*Maningkurano*	Arecaceae	Viand	Shoot
Caryota urens	*Baring berang*	Arecaceae	Viand	Shoot
Cocos nuchivera	*Ambhon*	Arecaceae	Beverages/Viand	Shoot/fruit
Licuala becarianan	*Oceta*	Arecaceae	Viand	Shoot/fruit
Rhopaloblaste ladermanii	*Wariang*	Arecaceae	Viand	Shoot/fruit
Arenga listeri	*Woseta*	Arecaceae	Beverages/Viand	Shoot/fruit
Arenga micrantha	*Ingkuri*	Arecaceae	Beverages/Viand	Shoot/fruit
Arenga microcacarpa	*Werang*	Arecaceae	Beverages/Viand	Shoot/fruit
Arenga pinata	*Terari*	Arecaceae	Beverages/Viand	Shoot/fruit
Most of dichotyledonae Group			Directly consumed/ cooked/vegetable	Fruit, leaves stem and tuber

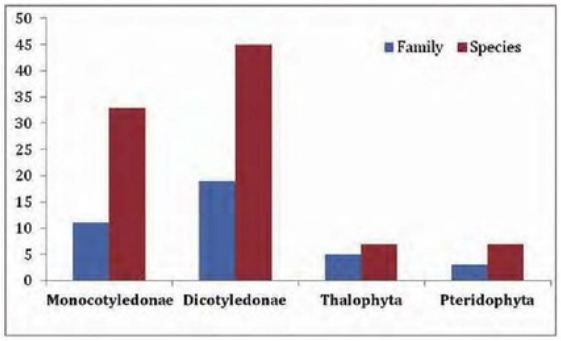

Fig. 2 —Number of species used as edible4 plant that classified based on its classes

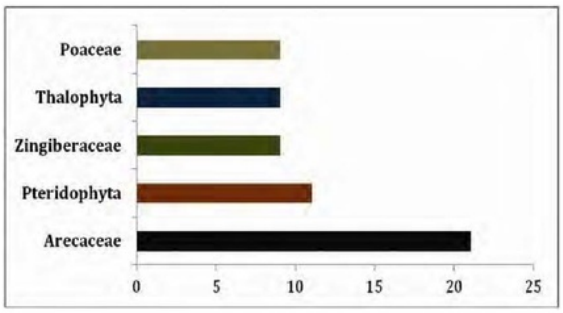

Fig. 3 —Group of forested which being dominant use

vegetation and mixed savanna. Fig. 2 indicates that the highest types of forest vegetation that is used for food cames from dicotyledonae with number used of nineteen (19) families, fourty-five (45) species then followed by monocotyledonae and thalophyta with eleven (11) families, thirty-three (33) species as well as five (5) families, seven (7) species respectively. While the lowest number used is pteridophyta with three (3) families and seven (7) species.

In general, the Fig. 3 also indicates that most of vegetation types used is of high plant species which roughly comes from tree species. It was being usage target due to provides more and more to be extracted if compared with other classes. In addition, tree also provides the biggest contribution in its use due to size and volume. Nutritional products that can be gathered from trees include fruits, nuts, seeds, leaves, bark and even sap. Those components can be used for wide range of purposes such as fruit commonly used in papua for meet a demand carbohydrate source and also vitamine. Besides, for vegetables people always used leaves and on occasion they used seed also as alternative.

Arecaceae was chosen due to it provides a variety of alternatives in its uses. Sastrapradja *et al.*[21] revealed that there are many types of palm benefit in supporting people life and it can be classified based on its usefulness such as carbohydrate source come from *Metroxylon sagoo* (sagoo), oil source come from *Cocos nucifera* and many others. Meanwhile Pteridophyta and other classes are also distributed widely throughout the island but relatively small in utilization. Zingiberceae is found mainly from Musaceae family therefore suitable for growing and rapidly adjust to an environment that grows in tropical rainforests[22].

Vegetation used

Fig. 4 points out the highest number used for fulfilling their necessary of life comes from fruit which reached 28% or about 36 species then followed

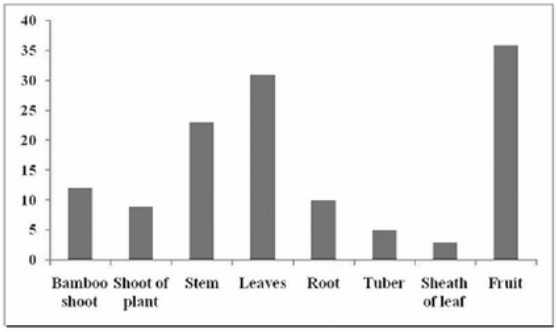

Fig.4 —Number of species and plant parts use for food resources

by leaves with 24% or approximately 31 species. Besides, stem also has being selected as food alternative by forest communities in papua which has been used around 23 species or reached of 18%. While bamboo shoot, root, shoot of plant, tuber and sheath of leaf were also selected only used in the small scale and also for particular tribe and sub-area. Fruits were being highly frequent consumed due to it has multi-significant effect and availability of relatively abundant in nature. Abdullah *et al.*[23] explain that Japanese people has always consumed fruit for their diet as well as dessert and snack which the average of 45.2 kg capita $^{-1}$ since 1965.

Fruit being selected by people to meet their necessary due to it provides many advantages such as it was significantly reduced fat and increased fiber for nutrition in a human body lifetime system, compared with other part of plant[24]. It can be easily found and also its availability as well as distribution almost in the area. While also, it was consumed because the tasty and healthy which fruits mainly contribute vitamins and minerals to balance the diet[25]. In the research found that Sowek tribe in Supiori has been used fruit of *Bruguiera gymnorrhiza* as a primary food and it used as an alternative of rice, sagoo and taro due to it contains lots of carbohydrate[26]. Meanwhile, there were around three species has been used for food i.e. *Heritiera littoralis*, *Soneratia alba* and *Soneratia ovate*. These species belongs to mangrove group and has used for long time by Inanwatan tribe in Sorong as food alternative sources.

Number of leaves used in Papua particularly for food source indicating quite high. Most of it were used for vegetable and vitamine source. Forest vegetation was highly frequently used comes from fern group and bamboo (shoot) that used for vegetable. Those was the highest used due to it spreaded all over the area and also has a suitable condition for growing up. From the research indicate there were four species of fern that has been used for vegetable in Puay village, Sentani which consisted of *Stenochlaena palustris*, *Athyrium dilatatum*, *Athyrium sorzogonense* and *Diplazium esculentum*. In addition, in Mappi regency found that there were five kinds of bamboo which has been used for vegetable by Yachai tribe in Mappi. They use it for consumed by combining with roasted sagoo or cassava and sweet potato. The habits has been existing for long time up to now. In both, the preparation and proccessing are also still displaying traditional ways purely.

However, other than for food, there were several species has also been used for meet a demand of pure water comsumption traditionally. These species used particularly when people taking a trip or hunting in the forest for a couple of days. Those species include *Cocos nucifera*, *Nypa fruticans*, *Calamus* sp. and *Arenga pinata*. Those are ecologically grow up in nature and potentially blossomed with its nature surrounnding. Besides, environmentally supporting conditions for being a exist plant also influenced by plant availability in the large number.

Staple and additional food

Furthermore result analysis showed there are classification in utilization of forest vegetation for their necessity. On the interview, shows that in selecting process based primarily on their local knowledge and its usefulness for their body. Result indicates there are six plants that used for meet their carbohydrate necessity *i.e. Metroxylon sagoo*, *Bruguiera gymnorrhhiza*, *Heritiera litoralis*, *Soneratia alba*, *Soneratia ovate* and *Nypa* (Table 2). From those species, sagoo is one of the most prefered plants due to it available in great number and has lots of benefit as well as a huge potency to be used globally. It is also supported by suitably environmental and growing conditions[27]. From research revealed that most of the island can easily be found except in middle part. In addition, mangrove ecosystems have also contributed greatly to meet cabohidrate needs. Investigation showed that the plant can be used by a series of cooking and extraction process to get the starch. This in turn will be used and processed to make cake[28]. Udofia and Udo[29] reveal that *Nypa fruticans* has many functions and one of them is to provide staple food. It has been used for long time, however its usefulness is still unknow yet.

Meanwhile, for secondary food shows that more than eighty various plant families have been used and eaten for meet their necessity include fruit, leaves and shoot for vegetable, etc. Those kind of plants frequently used as complement and also eaten together with primary food. This habitual has been exist since a couple centuris ago where all of papuan tribe still live for hunting and gathering as well as has a nomadic style. From reseach shows that most of plants has been used and come from a wide range families and genera. Research indicated that mostly has used for vegetables and processed by cooking. Leaf is one of the important part of plants that is often used particularly in fresh condition. From the study appears that Moile tribe has been used *Gnetum genemon* leaf to meet their needs. It was used as a vegetable and cooked in boiling water.

Conclusion

Non timber forest products particularly vegetation still play a crucial part in supporting the communities in Papua. It can be seen from result analysis where there are more than ninety species found and identified for meet people life. It also widely used for primary and secondary food and also which has lasted nearly a couple of centuries.

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GENERAL COMMENTS

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