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Diversity of indigenous vegetables in Puparn Royal Development Study Centre, Sakon Nakhon Province, Thailand

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Abstract: A study on diversity of indigenous vegetables in Puparn Royal Development Study Centre, Sakon Nakhon province during June 2015 to May 2016 was purposed to collect and classify the indigenous vegetables with revealing their potential as food resources, edible parts and utilization method. Sixty-three species, sixty genera and forty-three families were identified. The four majorities of plant families were Zingiberaceae, Fabaceae, Araceae, and Asteraceae, respectively. Additionally, identified indigenous vegetables could be classified into six groups based on consumed part including underground stem (4 species), leaves and young shoots (35 species), stem (2 species), flower (4 species), fruit (6 species) and whole plant (21 species). Most of utilization methods were used as salad, steamed or boiled vegetables eaten with chili paste, minced meat, or seasoning in food ingredients.

Keywords: indigenous vegetables, diversity, plant utilization, Sakon Nakhon province

Introduction

The Puparn Royal Development Study Centre is established in Ban Na Nok Khao, Huai Yang sub district, Muang district, Sakon Nakhon province on November 25, 1982. This centre is one of six development study centres that is settled in northeastern region of Thailand. A total land area is approximately 2,128 hectares (13,300 rais) comprising about 368 hectares (2,300 rais) of an agricultural development zone and 1,760 hectares (11,000 rais) of peripheral areas earmarked for forestry development that is located within Pa Phu Lom Khao – Phu Peck National Reserved Forests and Mai Kraya Loei Namphung Forest Project. Most of ecological systems in this location are natural forest consisted of Dipterocarp forest (60%), dry evergreen forest (13%), mixed deciduous forest (12%) and agricultural area (12%). Additionally, people who live in this area and nearby can get benefits from plants in this forest [Office of the Royal Development Projects Board (ORDPB), 2018].

There are many species of indigenous vegetables in Thailand especially northeastern region. Deewiset and Khumklang (1998) collected 139 species of indigenous vegetables in northeastern region. Khumklang et al. (2000) reported that there were more than 220 species of indigenous vegetables in Thailand and majority of them were found in the northeastern region. Indigenous vegetables can be consumed either wholly or in parts of plant. The edible parts of vegetables may be root, stem, leave, flower, fruit, rhizome or bulb. Moreover, some mushroom can also be consumed as vegetable (Shirai and Rambo, 2008; Nnamani et al., 2010; Chokthaweepanich et al., 2016). These local vegetables are not only an excellent source of vitamins and minerals, but they can also be used for several purposes such as food, medicinal plants, ornamental plants and household incomes (Omara-Achong et al., 2012; Abukutsa-Onyango, 2014; Srisawat et al., 2016; Sseremba et al., 2017; Phumthum et al., 2018).

Indigenous vegetables can be prepared from locally available resources for food and nutritional security. However, the local vegetables are known and take benefit in different patterns depend on traditional knowledge, tasting culture, location, seasonal availability and social group (Lee et al., 2008; Omara-Achong et al., 2012; Abukutsa-Onyango, 2014; Khuankaew et al., 2014). Although economic vegetables are widely eaten in Thailand at the present, indigenous vegetables are still important to people who live in the rural area (Agoreyo et al., 2012; Ayaz et al., 2015; Sseremba et al., 2017) because indigenous vegetables are cheap and substantial source of amino acid, protein, vitamins and minerals (Okafor, 1983). Moreover, many researchers reported beneficial effects from local vegetable consumption such as high antioxidant (Hong et al., 2004; Tangkanakul et al., 2006; Panpipat et al., 2010; Chao et al., 2014; Baang et al., 2015; Kongkachuichai et al., 2015; Tinrat, 2016), flavonoid contents (Baang et al., 2015; Kankanamge and Amarathunga, 2017), phenolic compound (Panpipat et al., 2010; Tinrat, 2016; Kankanamge and Amarathunga, 2017; Yakoh et al., 2018), preventing hypertension (Chuchote et al., 2015), etc.

Unfortunately, traditional thai vegetables are risk to loss since the younger generations who prefer the introduced species (e.g. broccoli, cabbage, cauliflower, lettuce, tomato, etc.), don't know cooking techniques or recipe using indigenous vegetables (Somnasang and Moreno-Black, 2000; Kolsuwat, 2002; Setalaphruk and Price, 2007). Homemade meals are substituting with fast food in Thailand (Kosulwat, 2002). Economic or introduced

vegetables are key ingredients in many dishes. Although many indigenous vegetables are sale in the local market, some people may know their plant name, kinds, cooking process (Shirai and Rambo, 2008). Therefore, it will be a worthwhile attempt to study on diversity and classification of indigenous vegetables covering their used parts and utilization method in the Puparn Royal Development Study Centre.

Materials and Methods

Study Area

This study was conducted in the Puparn Royal Development Study Centre located in Sakon Nakhon province, Thailand during June 2015 to May 2016. It is located between latitudes 17^0 04' to 17^0 07' north and longitudes 104^0 00' to 104^0 04' East (Figure 1). The range of height is between 180-420 meters above moderate sea level. The average temperature in this area is approximately 26.4^0C. The lowest temperature is around 12.1^0C and highest is around 37.9^0C. The average precipitation is 362.1 mm per year and average annual relative humidity is 72.9%. Soil condition in this study area is sandstone of conglomerate type and shale with lower layers of soil comprised shale, sandstone and limestone (ORDPB, 2018).

Data Collection

Indigenous vegetables were collected and photographed from three forest areas including Dipterocarp forest, dry evergreen forest and mixed deciduous forest. All samples were recorded plant ecology and morphological characteristics especially disappeared traits in herbarium specimens or preserved plants in alcohol-glycerine such as habit, latex, color, taste and flavor. Moreover, the local name, used part, and utilization methods also were gathered from local people. The collected plants were identified in the fields and laboratory by taxonomists or comparing with voucher specimens at Bangkok Herbarium Museum, Department of Agriculture, Bangkok. Finally, all specimens were reconfirmed using literature on the flora of Thailand, Flora of China and Thai plant names (Revised edition 2014) book (Smitinand, 2014).

Result & Discussion

Sixty-three indigenous vegetable species belong to 60 genera and 43 families (Table 1) were collected in the Puparn Royal Development Study Centre. They could be classified into 4 main groups including monocotyledonous plants 15 species, dicotyledonous plants 41 species, fern 2 species and fungi 5 species. The most discovered plant families were 5 species (7.94%) in Zingiberaceae, 4 species (6.35%) in Fabaceae, 3 species (4.76%) each in Araceae and Asteraceae. Moreover, They could be classified into 9 groups (Figure 2) depend on plant habit (Smitinand, 2014) consisted of tree 9 species (14.29%), shrub 9 species (14.29%), herb 25 species (39.68%), climbing 9 species (14.29%), scandent 1 species (1.59%), palm 1 species (1.59%), bamboo 2 species (3.17%), fern 2 species (3.17%) and fungi 5 species (7.94%). All fungi were 5 species of mushrooms that grew in the rainy season. Herbs were the dominant indigenous vegetables in this study because they contained less woody tissue in all vegetative parts than tree and shrub, whereas tree and shrub took longer time for new branch, shoot and fruit (Thongpukdee et al., 2014). Besides, the main features of surveyed areas were deciduous forest, open canopy and abundance of herbs in the ground layer (Rundel and Boonpragob, 1995).

The majority species of indigenous plants were found in Dipterocarp forest (34 species), mixed deciduous forest (30 species), wet areas (19 species) and dry evergreen forest (17 species), respectively. The Dipterocarp forest contained more indigenous species than others because this forest type covered 60% of all areas (ORDPB, 2018), while the mixed deciduous forest was indicated higher plant diversity when species-area ratio was examined (Figure 3). Dipterocarp forest was considered to be less diversity than evergreen forests or wet forests due to the conditions of low moisture, high temperature and low annual rainfall averages (Murphy and Lugo, 1986; Powers et al., 2018). Besides, most of trees in Dipterocarp forest are shedding their leaves in the dry season (Janzsn, 1998; Himmapan and Kaitpraneet, 2008; Elliiott et al., 2013).

The plant parts used from local people both in single or multiple preparations (Figure 4 and Table 1) were underground stem 4 species (6.35%), leave and young shoot 35 species (55.56%), stem 2 species (3.17%), flower 4 species (6.35%), fruit 6 species (9.52%) and whole plant 21 species (33.33%). The results revealed that the greater vegetable consumption was leave and young shoot because this part was young and appreciated for cooking. Additionally, leafy vegetables were quick to prepare and an admired source of food and medicine (Turreira-García et al., 2017). The investigation of this study reported that most utilization methods were used in cooked or fresh vegetables as salad, steamed or boiled vegetables eaten with chili paste, spicy minced meat, or seasoning in food ingredient. Furthermore, they could be cooked in a variety of dishes; for example, soup, stir-fried, curry or as a sweet dessert. Some lifestyle diet was similar to other regions in Thailand (Ngamsiri and Thananoppakun, 2014; Turreira-García et al., 2017) and other countries such as in Kenya (Gido et al., 2017), Nepal (Uperty et al., 2012), Nigeria (Nnamani et al., 2010; Arowosegbe et al., 2018).

Various indigenous species have been presented to be used several ways as well as vegetables, for instance, fruit (e.g. *Aegle marmelos*, *Antidesma ghaesembilla*, *Passiflora foetida*, *Garcinia cowa*, *Schleichera oleosa*); medicinal plants (e.g. *Acmella oleracea*, *Alpinia* sp., *Limnophila geoffrayi*, *Phlogacanthus pulcherrimus*, *Glinus oppositifolius*); ornamental plants (e.g. *Ardisia crenata*, *Curcuma sessilis*, *Curcuma singularis*, *Cratoxylum formosum*, *Caryota mitis*, *Nymphaea pubescens*); and sweet dessert (e.g. *Cissampelos pareira*, *Dioscorea alata*, *Dioscorea* sp.). Some local vegetables should not be eaten raw because of highly toxic prussic acid and must be cooked or fermented before consuming to neutralize the hydrocyanic acid (CSIR, 1950; Coursey, 1967) such as wild yam (*Dioscorea* sp.), giant taro (*Colocasia gigantea*) and unicorn plant (*Lasia spinosa*). Some indigenous vegetables in this study were reported as a good source of minerals and vitamins (Office of the Primary Health Commission. 1997; Nutrition Division, 2001; Sirival, 2008; Kingkachuichai et al., 2015): phosphorus (e.g. *Dracaena angustifolia*, *Lobelia chinensis*, *Persicaria odorata*); potassium (e.g. *Blumea napifolia*, *Dracaena angustifolia*, *Lobelia chinensis*,); calcium (e.g. *Blumea napifolia*, *Cissampelos pareira*, *Lobelia chinensis*); iron (e.g. *Diplazium esculentum*, *Hydrocotyle umbellata*); vitamin A (e.g. *Careya sphaerica*, *Centella asiatica*, *Cissampelos pareira*, *Hydrocotyle umbellata*, *Lasia spinosa*); and vitamin C (e.g. *Aegle marmelos*, *Careya sphaerica*, *Cissus hastate*, *Melientha suavis*, *Passiflora foetida*). Consequently, the local vegetables can help the rural people to prevent malnutrition (Omara-Achong et al., 2012; Kongkachuichai et al., 2015; Phumthum et al., 2018) and to get rid of common illness (Chotchoungchatchai et al., 2012; Khuankaew et al., 2014; Phumthum et al., 2018).

Conclusion

The Puparn Royal Development Study Centre can be represented as a major source of plant diversity. Forty-three families with sixty-three species of indigenous vegetables were encountered in different four ecosystems. A number of vegetables were found in the Dipterocarp forest. Leave and young shoot of diverse species were preferred to food preparation. There were alternative methods to make use of indigenous plants except vegetables such as medicine, ornamental plant or dessert. These vegetables are a good option for contributes to food and nutrition security.

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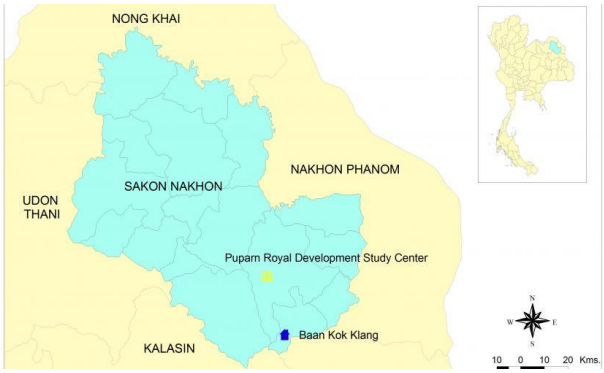

Figure 1. Map of the Puparn Royal Development Study Centre, Sakon Nakhon, Thailand
Source: https://www.iucn.org/content/combining-science-local-knowledge-ecosystem-based-adaptation-kok-klang-village-sakon-nakhon

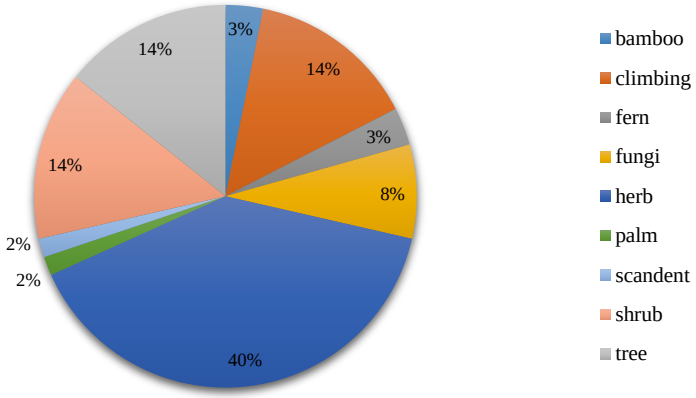

Figure 2. Classification of indigenous vegetables in the Puparn Royal Development Study Centre based on plant habit

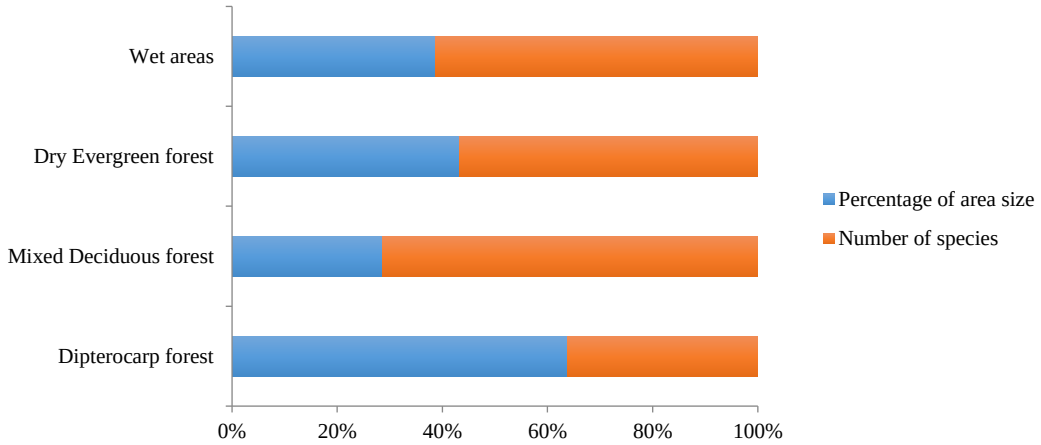

Figure 3. A comparison of species number within each forest type in the Puparn Royal Development Study Centre

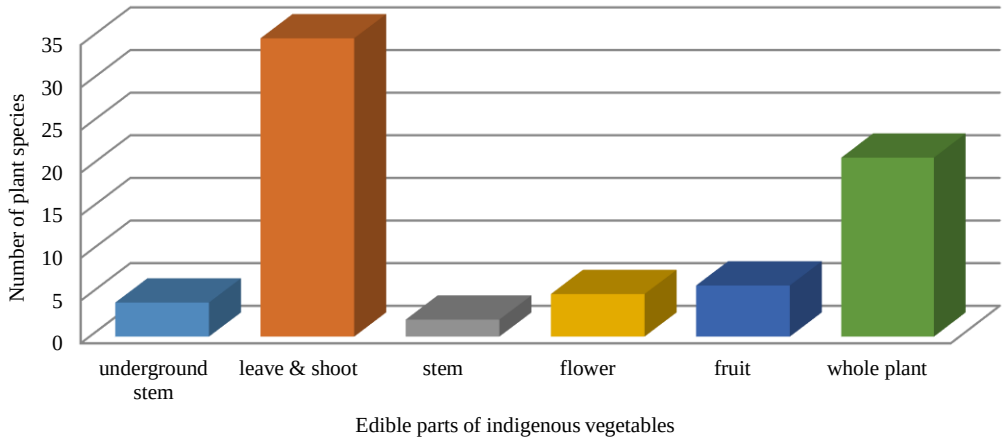

Figure 4. Edible part of indigenous vegetables in the Puparn Royal Development Study Centre

Table 1. Habit, ecosystem and edible parts of indigenous vegetables in Puparn Royal Development Study Centre

Family	Scientific name	Vernacular name	Habit	Ecosystem*				Edible parts**					
				DF	MDF	DEF	WA	Ust	St	Sh	Fl	Fr	Wh
Acanthaceae	*Phlogacanthus pulcherrimus* T.	Di pla chon	Shrub	/						/			
Alismataceae	*Limnocharis flava* (L.)	Phak phai	Herb		/		/						/
Amanitaceae	*Amanita* sp.	Het ra ngok	Fungi										/
Amaranthaceae	*Alternanthera sessilis* (L.) R. Br. ex DC.	Phak pet thai	Herb		/		/						/
Ancistrocladaceae	*Ancistrocladus tectorius* (Lour.) Merr.	Hu kwang	Climbing							/			
Apiaceae	*Centella asiatica* (L.)	Phak nok	Herb		/		/						/
	Hydrocotyle umbellata L.	Phak waen	Herb		/		/						/
Apocynaceae	*Aganonerion polymorphum* Pierre ex	Som lom	Climbing	/		/				/			
	Amphineurion marginatum (Roxb.) D.J.	Khruea sai tan	Climbing	/		/				/			
Araceae	*Amorphophallus* sp.	Buk	Herb	/	/	/		/	/				
	Colocasia gigantea	Bon	Herb		/		/						/
	Lasia spinosa (L.)	Phak nam	Herb		/		/						/
Arecaceae	*Calamus* sp.	Wai	Scand	/		/				/			
	Caryota mitis Lour.	Tao rang	Palm			/				/			
Asparagaceae	*Dracaena angustifolia* (Medik.) Roxb.	Khon Khan	Shrub	/						/			
Asteraceae	*Acmella oleracea* (L.)	Phak khrat hua	Herb		/		/						/
	Blumea napifolia DC.	Phak hon han	Herb				/						/
	Crassocephalum crepidioides (Benth.) S.	Phak kho on	Herb		/		/						/
Athyriaceae	*Diplazium esculentum*	Phak kut	Fern		/		/			/			
Auriculariaceae	*Auricularia auricula-judae* (Bull.) J.Schröt.	Het hu nu	Fungi										/
Campanulaceae	*Lobelia chinensis* Lour.	Phak khi som	Herb		/		/						/
Clusiaceae	*Garcinia cowa* Roxb. ex	Cha muang	Shrub	/						/			

Family	Scientific name	Vernacular name	Habit	Ecosystem*				Edible parts**					
				DF	MDF	DEF	WA	Ust	St	Sh	Fl	Fr	Wh
Convolvulace	*Ipomoea aquatica* Forssk.	Phak bung	Herb		/		/						/
Costaceae	*Cheilocostus speciosus* (J. Koenig) C. D. Specht	Ueang mai na	Herb	/	/	/				/			
Dioscoreaceae	*Dioscorea alata* L.	Man	Climb	/	/					/			
	Dioscorea sp.	Kloi	Climb	/	/			/					
Diplocystacea e	*Astraeus hygrometricus* (Pers.) Morgan	Het phao	Fungi										/
Ebenaceae	*Diospyros filipendula* Pierre ex Lecomte	Lam bit dong	Tree			/				/			
Fabaceae	*Adenanthera pavonina* L.	Ma klam ton	Tree	/						/		/	
	Caesalpinia mimosoides	Phak khaya	Climb	/						/			
	Crotalaria sp.	Hing hai	Herb	/	/	/				/			
	Droogmansia godefroyana (Kuntze)	Chai hin	Shrub	/						/			
Hypericaceae	*Cratoxylum formosum* (Jacq.) Benth. & Hoof. f.	Tio khao	Tree	/	/	/				/	/		
Lecythidaceae	*Careya aeborea* Roxb.	Kradon	Tree	/						/			
Lygodiaceae	*Lygodium polystachyum* Wall. ex Moore	Ya li phao	Fern	/	/	/							/
Melastomatac	*Melastoma*	Khlong khleng	Shrub	/	/	/				/		/	
	Memecylon scutellatum (Lour.) Hook. & Arn.	Mueat ae	Tree	/	/	/				/			
Menispermace ae	*Cissampelos pareira* L. var. *hirsuta* (Buch. ex	Khruea ma noi	Climb ing	/		/							/
Menyanthacea	*Nymphoides indica* (L.)	Bua ba	Herb				/				/		
Molluginacea	*Glinus oppositifolius* (L.)	Sadao din	Herb		/		/						/
Myrtaceae	*Syzygium antisepticum* (Blume) Merr. & L. M.	Phak mek	Tree		/		/			/			
Nymphaeacea	*Nymphaea pubescens*	Bua sai	Herb				/		/				
	Barclaya sp.	Phak lin fan	Herb				/			/			
Opiliaceae	*Meliantha suavis* Pierre	Phak wan pa	Shrub	/		/				/			
Passifloraceae	*Passiflora foetida* L.	Ka thok rok	Climb	/						/			
Phyllanthacea	*Antidesma ghaesembilla*	Mao khai pla	Tree	/						/		/	
Plantaginacea	*Limnophila geoffrayi*	Phak kha	Herb		/		/						/
Poaceae	*Gigantochloa albociliata* (Munro) Kurz.	Phai rai	Bamb oo	/						/			
	Vietnamosasa ciliata (A. Camus) T. Q. Nguyen	Phai chot	Bamb oo	/						/			
Polygonaceae	*Persicaria odorata*	Phak phai	Herb		/		/						/
Primulaceae	*Ardisia crenata* Sims	Ta kai bai	Shrub			/				/		/	
Russulaceae	*Russula densfolia* (Secr)	Het than	Fungi										/
	Russula emetica (Schaeff. Ex Fr.) Pers. S.f. Gray	Het num mak	Fungi										/
Rutaceae	*Aegle marmelos* (L.) Corrêa ex Roxb.	Ma tum	Tree		/	/				/		/	
	Clausena guillauminii	Song fa	Shrub	/						/			
Sapindaceae	*Schleichera oleosa*	Mak kho	Tree	/	/	/				/		/	
Symplocaceae	*Symplocos cochinchinensis* (Lour) S.	Chum cha	Shrub	/						/			
Vitaceae	*Cissus hastata* Miq.	Som sandan	Climb	/						/			

Family	Scientific name	Vernacular name	Habit	Ecosystem *				Edible parts**					
				DF	MDF	DEF	WA	Ust	St	Sh	Fl	Fr	Wh
Zingiberaceae	*Alpinia* sp.	Kha	Herb	/	/			/		/			
	Boesenbergia sp.	Krachai pa	Herb	/				/					
	Curcuma sessilis Gage	Krachiao	Herb	/	/						/		
	Curcuma singularis	Krachio khao	Herb	/	/						/		
	Kaempferia galanga L.	Pro	Herb	/	/					/			

Note: *Ecosystem: DF = Dipterocarp Forest; MDF = Mixed Deciduous Forest; DEF = Dry Evergreen Forest; WA = Wet Area

**Edible part: Ust = underground stem; St = stem; Sh = young shoot and leaves; Fl = flower; Fr = fruit; Wh = whole plant