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Wild medicinal and food plants used in Vietnam: a literature review

Bachelor Thesis

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Declaration

I hereby declare that I have written my bachelor thesis "Wild medicinal and edible plants used in in Vietnam: a literature review " by myself under the guidance of my thesis supervisor doc. Ing. Zbyněk Polesný, Ph.D. All used sources and data are quoted in the list of references. As an author of this bachelor thesis I declare I have not violated author rights of third persons.

In Prague, April 17 2015

Petr Pudil

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Abstract

Wild plants are important constituents of Vietnamese traditional remedies and dishes, but the knowledge of use of the plants is disappearing. Within this work a literature search on wild plants for medicinal and food purposes used in Vietnam has been done. In the Northern Vietnam there were 361 wild medicinal plant species recorded, distributed in 106 families, while in the Southern Vietnam 387 plant species were recorded, belonging to 121 families. Only one study inspecting wild edible plants from the Northern Vietnam was available. On the other hand, there were 177 plants among 79 families species recorded among wild edible plants in the southern Vietnam. The species with the highest numbers of records were identified and discussed. Considering the numerous ethnobotanical data, these plants should deserve attention as potential sources of phytoterapeuticals, nutraceuticals, and dietary supplements. However, further detailed pharmacological and nutrition studies are required in order to verify some of their nutritive and health beneficial properties.

***Key words**:* Ethnobotany, medicinal plants, traditional medicine, Vietnam, wild edible plants

Abstrakt

Planě rostoucí rostliny jsou důležitou součástí Vietnamských léků a pokrmů, navíc poskytují lidem mnoho dalších výhod. Znalost užívaní těchto rostlin nicméně mizí. V rámci této práce byla provedena literární rešerše na téma divoké léčivé a jedlé rostliny. V severním Vietnamu bylo zaznamenáno 361 rostlinných druhů náležících do 106 čeledí, zatímco v jižním Vietnamu bylo zaznamenáno 387 rostlinných druhů ze 121 čeledí. Dostupná byla pouze jedna studie zkoumající plané jedlé rostliny ze severního Vietnamu. V jižním Vietnamu bylo zaznamenáno 177 planě rostoucích jedlých druhů náležících do 79 čeledí. Rostliny s nejvyšším množstvím záznamů byly určeny a diskutovány. Tyto rostliny mohou být vzhledem k početným etnobotanickým záznamům doporučeny jako potenciální zdroje nových léčiv, nutraucetik a potravinových doplňků. Nicméně jejich zdraví prospěšné vlastnosti je nezbytné ověřit prostřednictvím dalších farmakologických a nutričních studií.

Klíčová slova: Etnobotanika, léčivé rostliny, tradiční medicína, Vietnam, plané jedlé rostliny

Contents

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List of Abbreviations:

FAO	Food and Agriculture Organization of the United Nations
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
NTFPs	Non-timber forest products
TCM	Traditional Chinese medicine
TVM	Traditional Vietnamese Medicine

Foreword

In this study, two types of NTFPs to review were chosen. Those are medicinal plants and wild edible plants, often intersecting each other. Research showed that many wild plants in local food cultures are inseparable from traditional therapeutic systems (Gessler and Hodel 1996; Moreno-Black et al., 1996; Etkin and Ross 1982). The idea of "food as medicine" has been there since ancient times and has existed in Asian medical theories and food therapy (Weng and Chen 1996), which has been of great influence in Vietnam. It is known that man have utilized plants as a source of medicinal drugs for thousands of years.

Medicinal plants are of a great value for the development of pharmaceutical products, phytomedicines and dietary supplements (King et al., 1999). They can be used as raw material for further extraction of active compounds, as preparations for herbal and indigenous medicines, and some plants also as energy-rich food (Prosea, 1999). To follow the indigenous knowledge on medicinal plants is an effective way to find new drugs (Swerdlow, 2000), while much of the knowledge is still transmitted just orally and we do not know biological effects and constituents of many plant species (Prosea, 1999). Totally about 80 % of the world´s population relies on traditional medicine (Farnsworth et al., 1985), and especially in remote areas of developing countries, medicinal plants may form the only available source of health care as the hospitals are not everywhere and western medicine is much more expensive (Hoang et al., 2008). Despite of that, knowledge of medicinal plants as a part of many indigenous cultures is rapidly disappearing. The knowledge of species, distribution, ecology, management and extraction of medicinal plants is on decline (Do et al., 2002). Vietnamese traditional medicine has ancient traditions. Theoretically it was built on a combination of Vietnamese traditional medicine, Chinese medicine, and with some influence from Ayurvedic traditions (Loi and Duñg, 1991; Manderson, 1987). Traditional medicine is well integrated into the national health system and has largely contributed to community healthcare (Prosea, 1999; Bui CH, 1993). Within the health system, gathering and cultivation of medicinal plants is systematically promoted as well (Ogle et al., 2003).

Vietnam is also rich in wild plants traditionally included in the food basket (duc Duc, 1988). They cover a great part of rural people non-rice food consumption (Clendon, 2001). Wild edible plants are a diverse group of plants with multiple and often overlapping functions. (Ogle, 2001) They are important source of micronutrients and play an important role in nutrition (Grivetti and Ogle, 2000).

1. Introduction

1.1 Study area

1.1.1 Location and geography

The Socialist Republic of Vietnam is a South-Asian state in the easternmost part of the Indochina Peninsula. Located between 102° 09' to 109° 30' longitude and 8° 10' to 23° 24' east latitude (Nguyen, 2004), it covers a land of approximately 331 thousands square kilometres (GSO, 2013). From the north to the south, Vietnam stretches for about 1600 kilometers. In the thinnest part it is just 50 km wide. On the ground, Vietnam borders with China, Laos and Cambodia. In the east is the South China Sea, in the southwest is the Gulf of Thailand and the Gulf of Tonkin is in the northwest, as can be seen in Figure 1 (Encyclopedia Britannica, 2014). The country divides into the Red River Delta and northern highlands in the north, the Mekong River Delta in the south, the Annamite range on the border with Laos continuing to the south into the Central Higlands, and along the coast lie lowlands (Cima, 1989). Almost half of Vietnam´s population live in fertile areas around the two big rivers (GSO, 2009). The Red River Delta is smaller but more densely populated and developped, it is home to ethnical Vietnamese (*Kinh*). The delta is subject to frequent flooding, which has been used to irrigate the rice fields in rich alluvial soils there by building an extensive system of canals and dykes (Cima, 1989). The Mekong Delta is wider, it is a low-level plain not more than three meters above the sea level. It´s fertility and traditional use make the area one of the world´s major rice-growing regions. Highlands in the north and the northwest are very irregular in elevation and form, there are several high plateaus and also the highest peak of Vietnam Fansipan (3.142 m). Tribal minority groups are the main inhabitants there (Cima, 1989). Within Southern Vietnam lie the Central Higlands. It consists of 5 plateaus. There is a lot of arable land with often fertile soils. The Higlands had been used for the relocation of people from the overpopulated lowlands in the 80´s, which can be observed in the ethnic composition there (Cima, 1989). The Coastal lowlands extend from north to south along the coast with conditions not very good for agriculture (Cima, 1989). Natural land cover is generally composed by non-deciduous tropical forest in the south, alternately moist forest mainly in the north and mangroves. Vietnam has many coastal lagoons, estuaries, mangroves, dunes, beaches, tidal flats and sandbars along the coast plus 3000 islands. Beaches and dunes

characterize areas of the central coast, while mangroves can be found in the Red River and the Mekong Delta (Carew-Reid et al., 2010). On deforested places, sparse secondary vegetation of trees and shrubs with grass underbrush started to spread. This type of vegetation occupies a big part of Vietnam´s total area nowadays (Nguyen, 2006). There are also large areas of mostly natural bamboo forests (FSIV, 2009).

Figure 1. Map of Vietnam

1.1.2 Climate

Vietnam has a tropical monsoon type of climate with big amount of sunlight, rain and humidity. There is a single rainy season which takes place during the south (summer) monsoon. It is from May to September. During those months falls the most of the rain, almost everywhere over 1 000 mm, and in the hills facing the sea it can be even 2 000 – 2 500 mm. During the south monsoon, in the country prevail south and south-eastern winds. The northern (winter) monsoon, which takes place between October and April, brings winds from the north and the northeast. In this period, rainfall is usually light and infrequent. Between monsoon seasons there is a transition period when winds are light and their direction may vary (Encyclopedia Britannica, 2014). Typhoons many occur from May to January, while historically affect Vietnam every year 6-8 typhoons (MoNRE, 2010). The Northern Vietnam has usually cloudy days with occasional light rain and drizzle in the time of the north monsoon. It is cooler than in the south in winter, wind can sometimes bring cool air from the north from China. In high positions can sometimes occur snowing. Janaury is usually the coolest month there (MARD, 2010). The annual mean temperature of Hanoi is 17 °C while for Ho Chi Minh City in the south it is 27 °C (Encyclopedia Britannica, 2014). Southern Vietnam with its lowlands is protected from the north so the drier season is sunny and hot and generally it has higher tempearatures, humidity and more sunlight than the north (MARD, 2010).

1.1.3 People

In Vietnam takes place regular people census every few years. During the last one it was found that the number of population was nearly 89.7 million citizens (GSO, 2013), by now it is for sure over 90 million. Vietnam is the country with the third biggest population in Southeast Asia, after Indonesia and the Phillipines. Data also showed that urbanization is almost 30% and population density 271 ppl/km^2 (GSO, 2013). Neverthelless, the population growth has been decreasing in the last three decades (GSO, 2010).

Nowadays there are 54 official ethnic groups living in Vietnam, as can be seen in the Table 1. Since 1979, the government classification system has distinguished ethnical

Vietnamese, called *Kinh* or *Viet*, and 53 ethnic minorities (Keyes, 2002). Most of their languages belong to 5 language families of Southeast Asia, which originated in the cultural and historical space between the southern curve of the Yagtze River and the islands of Southeast Asia (Dang et al, 2000). The *Kinh* make about 86 % of the whole population and are the core of national identity, culture and politics. They predominate in lowlands, traditionally cultivating paddy rice (Ogle and Price, 2008). The biggest ethnic minorities are *Tay, Thai, Muong, Khmer* (ethnical Cambodians), *Hmong* and *Hoa* (ethnical Chinese), all together they create around 10 % of the population and the rest of minorities is just 4 % (GSO, 2001).

Table 1**.** Official ethnic groups of Vietnam

1.	Ba Na	19.	HàNhì	37.	Nùng
2.	Bố Y	20.	Hmông	38.	Ơ đu
3.	Brâu	21.	Hoa	39.	Pà Thẻn
4.	Bru-Vân Kiều	22.	Hrê	40.	Phù Lá
5.	Chăm	23.	Kháng	41.	Pu Péo
6.	Chơ ro	24.	Khmer Krom	42.	Răglai
7.	Chu ru	25.	Khơmú	43.	Rơ-măm
8.	Chứt	26.	La Chí	44.	Sán Chay
9.	Co	27.	La Ha	45.	Sán Dìu
10.	Cống	28.	La Hú	46.	Si La
11.	Cơ Ho	29.	Lào	47.	Tày
12.	Cơ Lao	30.	Lô Lô	48.	Tà ôi
13.	Cơ Tu	31.	Lự	49.	Thái
14.	Dao	32.	Ma	50.	Thổ
15.	Ê đê	33.	Mảng	51.	Việt/Kinh
16.	Giáy	34.	Mnông	52.	XinhMun
17.	Gia Rai	35.	Mường	53.	Xơ-đăng
18.	Giẻ-Triêng	36.	Ngái	54.	Xtiêng

Adopted from: Hoang and CEMA, 2010

Talking about the most numerous ethnical minorities, the most of *Tay, Thai, Muong* and *Hmong* live in the north. The *Tay* live in northern mountanious provinces Lang Son, Cao Bang, Tuyen Quang; The *Thai* in the north-westestern provinces as well as in Nghe An and Than Hoa; Muong in Hoa Binh, Thanh Hoa and Phu Tho. The *Hmong* inhabit areas mainly along the northern borders in provinces Ha Giang, Dien Bien, Son La and Lao Cai, (UNFPA, 2011) while much more of them live in Laos and China (GSO, 2012). In the south, around the Mekong river delta in Soc Trang, Tra Vinh and Kien Giang provinces, live most of the *Khmer*

(UNFPA, 2011). The *Hoa* had come from China and most of them are in the cities nowadays, while the smaller part is living in the country in Southern Vietnam (GSO, 2012). A difficulty for the ethnic minority people as compared to the *Kinh* can be their low mobility which brings much less experiences with the wider surrounding and the world, and sometimes also lesser knowledge of national language (The World Bank, 2009). The people have been influenced mainly by China throughout the ages, and also by the Western culture, especially recently. Influences are stronger at the coast and in the lowlands than in the highlands (Encyclopedia Britannica, 2014).

Several studies on the indigenous knowledge of plant use including healing plants were carried out among many ethnics across the whole Vietnam, most of them is focused on more than one ethnic. Interviews were conducted with *Thai* (Do et al., 2002; Hoang VS, 2002; Hoang et al., 2008), *Dao* (Do et al., 2002; Hoang VS, 2012), *Muong* (Hoang VS, 2012; Hoang et al., 2008), *Kinh* (Hoang et al., 2008; Ogle et al., 2003), *Hmong* (DS et al., 2002), *Hre* (Vo VM et al., 2014), *Tho* (Hoang et al., 2008), *Co Tu* (Ogle et al., 2003; Tran Thien An & Ziegler; 2001), *Pa Ko* (who are currently cassified as sub-group of *Ta Oi* ethnic group) (Ogle et al., 2003) and *Van Kieu Bru* (Tran Thien An & Ziegler; 2001).

1.1.4 Natural biodiversity

Vietnam is a part of the Indo-Burmese biodiversity hotspot which includes the Down Mekong River, Northeast India, Eastern Bangladesh, Burma, the Chinese province of Yunnan, Laos, Vietnam, Thailand and part of the Malaysian peninsula (Myers et al., 2000). Vietnam´s species composition is highly influenced by the South Central China biodiversity hotspot (Choudhary et al., 2008). Vietnam has 14 terrestrial ecoregions, each possessing wide spectre of conditions and organisms (Olson et al., 2001). Such floristic conditions bring Vietnam rich and diversified herbal resources. Data suggest that Vietnam is considered one of the world´s areas with the highest agro-biodiversity (Schmidt et al., 2008). It possesses almost 14 thousands of known plants species, of which 11.373 are vascular species (Bich et al., 2005). Vietnamese medicine uses nearly 4 thousands of them (Nguyen and Nguyen. 2008; Nguyen, 2003; Chi 1997). Around 900 of these plants are widely mentioned in traditional literature.

The diversity of animal species is also great. The National Biodiversity Action plan from 1995 reports on 275 species of animals, 800 bird species, 180 reptile species, 80 amphibian species, 2,470 fish species, and 5,500 insect species (Vietnam Government & GEF, 1995). Moreover, Vietnam is a country with high endemism, especially areas of The Annamites, karst limestone formations, or the Hoang Lien Mountains. Lowland forests are source of great plant species diversity, while upland forests present important habitat to many threatened animal species (Carew-Reid et al., 2010).

There is a high demand for NTFPs, including strongly wild edible and medicinal plants and their products, so that huge amounts of raw medicinal material are exploited from the wild nature. A lot of people consider those common resources to belong to everybody and collect them wastefully. For example, lots of collectors do not distinguish between an old and a young plant, they take everything. Taking away regenerative capacity of the plants by exploiters leads to exhaustion of medicinal plant resources and a lot of species are about to extinct (Khanh, 2005). Despite of this, some ethnic people are aware of that and have their ways to maintain the plants while continuously taking the medicine material. They for example do not take the tops, just the leaves (Do et al., 2002) or prefer leaves when it would be possible to use also the roots as well. Pollution of the Vietnamese environment is another serious problem in some areas as industrial zones and sub-urban areas. Intensive production and the overuse of agrochemicals and fertilizers in some places resulted in toxic residues in agricultural products as well as increased resistance and adaptability of crop patogens. Natural resources are being over-exploited, which leads to ecological imbalance and natural depletion and biodiversity deterioration. Wild plants and animals, forests, groundwater, aquaculture resources and also other sources appeared to be over-exploited (The Socialistic Republic of Viet Nam and FAO, 2013).

1.1.5 Agriculture

Vietnam is a country with great agricultural potential. Data from MARD (2013) say that 32 % of the area of Vietnam is used as agricultural production land and another 28 % of the area is used as productive or special use forest. Low labour cost helps to attract foreign investments. The country predominantly produces for export. Currently, it is the biggest pepper and the second biggest rice and coffee exporter in the world. Food and beverage

processing is the largest industrial activity of Vietnam. There is a huge variability in agriculture products. Vietnam has big production of commodities as paddy rice, maize, cassava, vegetables, fruit, coffee and tea, natural rubber and others. As for livestock, pigs, cattle and chicken are important, according to FAOSTAT data from the year 2012 (FAOSTAT, 2014). The most important agricultural areas are the Red River Delta, the Mekong Delta, and the southern region of terrace fields. The Central Highlands have variable conditions for agriculture ranging from unsuitable to good. Both the climate and the geology brouht Vietnam variable soil conditions. In the north, there are typically red soils because of a high amount of iron oxide, usually with a higher amount of nutritients in the lower layers. The soils of the Red River delta may vary from fertile with big potential to lower quality soils lacking soluble bases. Around the Mekong River Delta we can find alluvial soils, and the terraces along the Mekong River were built on gray podzolic soils, lateric soils and rich black regurs, which all could be found in the Central Higlands too. The coastal area of central Vietnam has mainly underdeveloped regosols and noncalcic brown soils, so it is not very good for agriculture (Encyclopedia Britannica, 2014; Nguyen, 2006). The main crop for Vietnamese agriculture is rice (*Oryza Sativa* L.), occupying most of the arable land. It is grown mainly in the Red River and Mekong river deltas. Other commonly grown grains are sorghum (Sorghum spp.) and maize (*Zea mays* L.). The Maize production has grewn rapidly in the last decade because it is highly needed for livestock feeding. Around 90 % of all planted maize are hybrids (The Socialistic Republic of Viet Nam & FAO, 2013). Sugar cane (*Saccharum officinarum* L.) is grown for the saccharide content and is used for livestock feeding, sugar production, drinks etc. There is a wide variety of fruit trees, for example bananas (Musa spp.), citruses (Citrus spp.), mango (Magnifera spp.), papaya (*Carica papaya* L.), jackfruit (*Artocarpus heterophyllus* Lam.), coconut (*Cocos nucifera* L.), longan (*Dimocarpus longan* Lour.), litchi (*Litchi chinensis* Sonn.), rambuttan (*Nephelium lappaceum* L.) and others. Great plantations of citrus trees, bananas and coconuts are grown in and around the Mekong River Delta, which is the mayor produce place for fruit. Mulberries (Morus spp.) are planted mainly to feed the silkworms. Other tree species as areca palms (*Areca catechu* L.) or cashew (*Anacardium occidentale* L.) produce nuts. Kapok trees (*Ceiba pentandra* (L.) Gaertn.) are grown for their fibre. Coffee and tea plantations spread across the area of the Central Highlands. Leguminous crops are grown widely for their high contain of proteins for food and feed. Vietnamese grow soybeans (*Glycine max* (L.) Merr.), groundnuts (*Arachis hypogaea* L.), beans (*Phaseolus coccineus* L., *P. lunatus* L., *P. vulgaris* L.), cowpea

(*Vigna unguiculata* (L.) Walp.) and many more. Among others, root plants as potatoes (*Solanum tuberosum* L.), sweet potatoes (*Ipomoea batatas* (L.) Lam.), cassava *(Manihot esculenta* Crantz) and taro (Colocasia spp., Xanthosoma spp.) are grown as well (FAOSTAT, 2014; IFPRI, 2002).

Rural households produce food for themselves so they do not need to buy all ingredients needed for cooking. They grow it on a field or in their homegarden, where more precious and often used plants (e.g. healing plants, spices) are planted. Fruit and vegetables are grown in most rural households in Vietnam is grown fruit and/or vegetables. Allmost all households grow banana trees and water morning glory (*Ipomoea aquatica*). Other usually grown fruit trees are for instance jack fruit and durian (Durio spp.) (IFPRI, 2002).

As intensively cultivated areas, the above-mentioned homegardens (*vuon nha*) provide important resources for families. They combine vegetable and fruit gardening with fish ponds and livestock. Diverse species are grown there, providing food, spices, stimulants, medicines, beverages, fodder, shelter and materials necessary for festivities. There are few types of homegardens. Homegardens with fruit trees are frequent in Southern Vietnam. In the Red River Delta and Central Vietnam, gardens with a pond and covered livestock as well as vegetable gardens are common. Minorities in the northern mountainous regions usually have homegardens with forest trees (Trinh et al., 2003). In Northern Vietnam, houses are typically oriented to the south which is better due to summer and winter winds. In the Southern Vietnam, where winds are not of such importance and population density is higher, houses are mostly oriented facing the road or waterway (Trinh et al., 2003). Behind the house there are are fruit trees, bigger ones (e.g. *Manilkara zapota* (L.) P.Royen) provide shadow for people and livestock. Opened places in gardens with a lot of light are well suitable for vegetables (e.g. *Solanum undatum* Lam., *Brassica oleracea* L.). As for vegetables mainly leafy green ones are grown as cabbage for example. (IFPRI, 2002). Crops demanding higher moisture (e.g. *Ipomoea aquatica* Forssk., *Eichhornia crassipes* (Mart.) Solms, *Sagittaria sagittifolia* L.) are grown around ditches and ponds (Hodel et al., 1999). Borders of homegardens are made of bamboo or sugarcane in the side or in the back, while cacti may be used in the front as a lower fence (Trinh et al., 2003). As people's primary and often the only source of meat comes from their homegardens, livestock is very common, in many families it functions as a self-supply of food and also as a chance to earn some extra money for the family. Most usual are pigs and poultry for meat. For the work in fields are used mostly buffalos. In lowlands there are many ponds used to hold water, for fishery (favourite fishes are e.g. black carp and

grass carp), and ducks to recycle the vegetal waste as feed (Wells-Dang, 2012; Trinh et al., 2003).

1.2 Traditional medicine

1.2.1 History

The history of traditional Vietnamese medicine traces thousands of years back. People were slowly accumulating knowledge by trail and error using plants and other materials which were not part of their usual diet to treat various illnesses (Prosea, 1999). Vietnamese Medicine dates back at least to the 2nd century BC (Duc, 1995). Traditional medicine in Vietnam can be broadly divided into two types: One kind of treatment process was created by Vietnamese peoples using materials native to Vietnam and is known as the Southern medicine (*Thuoc Nam*), or TVM. The other treatment process was developped by ethnic Chinese people using materials native for China, so it is called TCM or the Northern medicine (*Thuoc Bac*). Differences are in used plant species, preparations and purposes. Generally it can be said that TVM uses more of raw materials and is primarily aimed at curing diseases and ailments. TCM is thought to be more complex using advanced preparations and aimed chiefly at strengthening and enhancing the body. Both methods have influenced each other over time, which led to refining existing techniques and developing new treatment process and medical remedies. There are also healers practicing both branches or combining them. To prepare remedies, traditional medicine uses both plants and animals resources. Therefore remedies can be of animal, plant and also mineral origin, as well as mixed up (Nguyen and Nguyen, 2008). Among important personalties of traditional Vietnamese medicine as the most influential is considered famous physician Tue Tinh who lived in the 14th century, he wrote "*The Miraculous Effect of Traditional Medicine*" (*Nam Duoc Than Hieu*) also called *"The Miracle of Southern Medicine*" with more volumes and 580 plants against 182 diseases. His next important book was *"Medicinal Book from Hong Nghia Village"* (Hong Nghia Giac Tu Thu) containing around 600 ingredients of traditional medicine. Then in the 18th century Le Huu Trac, writing as Hai Thuong Lan Ong, carried out *"Treatise on Medical Knowledge Accumulated"* (*Hai thuong y tong tam linh*) with more than 30 volumes. So the basis for TVM was formed (Nguyen & Nguyen, 2008; Bao Chau Hoang, 1998; Duc, 1995; Loi and Duñg. 1991). During the reign of France in Vietnam, French botanists did a lot of research on plants including wild edibles and medicines, some results were published in the book

"*General Flora of Indochina*" *(Flore Generale de L'Indochine).* But the regime wasn´t promoting traditional medicine and it stood back to the western medicine though there had been publications on traditionally used materials since the 19th century. Since the 1950´s, the government has supported research on medicinal plant resources to be used in primary health care (Nguyen and Nguyen, 2008). Nowadays, the traditional medicine is well-integrated in the health care system and is used together with conventional western medicine. Most of the knowledge about medicinal plants is still found by experiences of ethnic local communities. Most of the plants are even nowadays used in traditional forms, but some compounds are extracted industrially (Ogle et al., 2003; Prosea, 1999).

1.2.2 Knowledge of medicinal plants

Medicinal plants have multiple important roles for people as disease treatment, income and keeper of cooperation and help in a community. Great part of people from the ethnic minorities lives in very remote areas, far and isolated from other groups of people. During thousands of years, every such group of people has accumulated knowledge of using plants for health care and disease treatment. Ethno-medicinal plant use and knowledge may vary significantly between ethnics and also between communities. Therefore it can reflect the cultural diversity. The knowledge of medicinal plants is owned by a family and it is usually kept in secret and handed down orally. Only very few members of a family have larger knowledge of healing plants and experience with healing. Those people are mostly women. (Khanh, 2005) Though the medicinal plant knowledge is being mostly transmitted orally, there are exceptions. In *Cham* ethnic, families own a written manual containing recipes inherited as family secret. This can also be seen in some *Kinh* families (Vu et al., 2013). For the people living in remote village areas medicinal plants can be the only available cure and healthcare. It is mainly caused by the high cost of many modern drugs and also pharmacies and hospitals are not available everywhere (Nguyen and Nguyen, 2005). Nevertheless, it was reported that if they had enough money, most of them would choose modern drugs because they are considered to be more effective (Hoang et al., 2008). The biggest part of plant species is harvested from the wild, while a smaller part is planted in homegardens, especially rare and hard-to-get endangered species. Some species are both planted and harvested from the wild (Hoang, 2012). Medicinal plants are collected from the wild in different vegetation types as

primary, secondary and logged-over forests, along streams, paths, roads and fields. Some plants considered as worthless by one group of people can be found precious by others. Also both groups can know it but use different parts and do not know the other use. These groups of people sometimes live very near each other, even in the same village (Khanh, 2005).

The whole plant or just some parts can be used to make a remedy. Sometimes, different parts can have different effects. Remedies can be made either from a single part of one plant species or as a mixture of many species and components, sometimes inclusive of animal materials. Common medicine preparations are for example decoction, paste, juice, chewing, boiling, soaking in alcohol etc. Making a decoction means boiling water with plant parts until the liquid is reduced to about one half ore one third of the volume. Pastes are made by crushing or chewing. Juice is liquid to be drunk after plant component extraction (Hoang et al., 2008). Medicinal plants are widely used as extracting material in pharmaceutical industry and exploited in large quantities. These plants are among others: *Artemisia annua* L. for artemisin and arthesunat to treat malaria, *Sophora japonica* L. for rutin as a bioflavonoid, *Fibraurea tinctoria* Lour. for palmatin, *Coscinium fenestratum* (Goetgh.) Colebr. for berberin etc.

Most commonly treated diseases vary according to people´s genetic predispositions, lifestyle and environment. It can be digestion and stomach problems, skin diseases, weakness, cold and others. A great part of plant species is used to treat those common diseases. On the other hand there are plants with very specific and unusual effects (e.g. a plant which makes dying people able to talk to their relatives longer). It is usual that common diseases are treated by a woman at home while a professional healer with more experiences is called in case of more serious diseases (e.g. hepatitis, tumor). However the procedure can vary between communities (Hoang, 2012).

1.2.3 Commercialization of medicinal plants

Selling medicinal plants can contribute significantly to generating income of households (Hoang VS, 2012), while somewhere, as for example in the Sa Pa district, it can be the main source of income for many households and villages (Delang, 2012). Every once in while (week for many markets), people who collect the plants go to town where there is a market and they sell their stuff themselves, or through a bigger seller. Seller´s prices in a market

differ according to season and daytime. The price can also change dependently on how much was sold and is on stock that day (Delang, 2012).

Vietnam is also into large quantity trade with medicinal herbs. The main country for export is China as Vietnam's most important trade partner. Its other big export markets are in Thailand, Singapore, Taiwan, Japan, Korea, Indonesia, USA, the UK, Germany, Hungary, the Netherlands, Poland and Bulgaria. Plants like *Amomum aromaticum* Roxb., *Anoectochilus setaceus* Blume, *Cibotium barometz* (L.) J.Sm., *Cinnamomum* cassia (L.) J.Presl, *Dendrobium nobile* Lindl., *Morinda officinalis* F.C.How, and many others are being exported in large quantities. The uncontrolled export of medicinal plants to China has exhausted some wild medicinal plant resources, rendering several species vulnerable to extinction. The main importer is also China. Lot of imported plants are not cultivated in Vietnam (e.g. *Coptis chinensis* Franch., *Ginkgo biloba* L., *Thalictrum foliolosum* DC., *Polygala japonica* Houtt.) or are just not produced in ammounts large enough to feed the demand (e.g. *Tetrapanax papyrifer* (Hook.) K.Koch, *Artemisia lactiflora* Wall. ex DC.) (Nguyen and Nguyen 2008).

1.2.4 Ethnopharmacological research

Modern medicine sees medicinal plants as reservoirs containing many natural bioactive compounds. Secondary plant metabolites represent compounds of a wide range of biological activities (Bernhoft, 2010). There were a few ethnopharmacological studies considering larger numbers of Vietnamese medicinal plant species.

Many medicinal plants of Vietnam are well-known for their antioxidant activity which can bring benefits in numerous aspects of health. Natural antioxidants are recently getting more attention as safe alternatives to conventional western biomedical products. Nguyen and Jong-Bang Eun (2011) investigated *Premna serratifolia* L., *Terminalia nigrovenulosa* Pierre, *Pseuderanthemum latifolium* B. Hansen, *Streptocaulon juventas* (Lour.) Merr., *Eclipta alba* (L.) Hassk. and *Solanum procumbens* Lour.) on their antioxidant and radical scavenging activities. The highest metal chelating activity was observed in methanol and water extracts of *T. nigrovenulosa* and *S. juventas* and methanol extracts of *E. alba*, *T. nigrovenulosa* and *P. integrifolia* extracts were found to have strong reducing power, DPPH radicals scavenging activities and also high levels of total phenolics. Those three plants mentioned above have significant potential for being used as natural antioxidants (Nguyen and Eun, 2011). Another

study focused on antioxidant effects of three Vietnamese edible and medicinal plants were evaluated from which *Syzygium nervosum* A.Cunn. ex DC. and *Syzygium zeylanticum* (L.) DC. showed strong antioxidant activity (Sone et al., 2011).

Nguyen and Eun (2013) also tested the same plants as in their study about antioxidant effects mentioned above for their antimicrobial effects. Almost all extracts proved to have antimicrobial effects on the tested microorganisms *Bacillus subtilis, Candida albicans, Escherichia coli, Lactobacillus brevis, Staphylococcus aureus, Pseudomonas aeruginosa, Saccharomyces cerevisiae, Aspergillus niger* and *Penicillium cyclopium*. The most effective extracts against *S. cerevisiae* were made from *P. latifolium, S. juventas* and *S. procumbens*. High effect against *C. albicans* was observed in *S. hainanense* and *P. serratifolia* extracts. The extract from bark and leaves of *T. nigrovenulosa* had a strong effect against *A. niger* and *P. cyclopium*. The extract of *P. serratifolia* showed relatively strong effects against the same two mentioned just before. The *T. nigrovenulosa* extract was also found to be the most effective on *E. coli, S. aureus, B. subtilis* and *P. aeruginosa*. *S. juventas* extracts were found to be the second most effective. Almost all extracts showed antibacterial activity against both gram positive and gram negative bacteria.

A study dealing with antimalarial and cytotoxic effects of chosen medicinal plants of Southern Vietnam was published by Nguyen-Pouplin et al. (2007). Extracts were prepared from 49 plant species and tested for their *in vitro* activity against *Plasmodium falciparum* and assessed for cytotoxicity against human cells to determine their selective index. 46 of the species showed a significant *in vitro* antiplasmodial activity (parasite growth inhibition greater than 30%). Among them, two species (both of genus Menispermaceae) were of the strongest antiplasmodial activity and high selectivity: *Arcangelisia flava* (L.) Merr. and *F. tinctoria*. *Harrisonia perforata (Blanco) Merr., Irvingia malayana* Oliv. ex A.W.Benn., *Elaeocarpus kontumensis* Gagnep. and *Anneslea fragrans* Wall. had similar effect. Another study on antimalarial effects of plants collected in the Southern Vietnam tested 42 extracts from 14 species (*Artemisia apiacea* Hance, *A. vulgaris, Ceiba pentandra, Coscinium fenestratum, Eurycoma longifolia* Jack, *Lasia spinosa (*L.) Thwaites, *Marsilea quadrifolia* L., *Mimosa pudica* L., *Phyllanthus amarus* Schumach. & Thonn, *Reynoutria multiflora* (Thunb.) Moldenke, *S. juventas, Tinospora sinensis* (Lour.) Merr., *T. crispa* (L.) Hook. f. & Thomson, *Xanthium strumarium* L.). Each plant species possessed at least one active extract having antiplasmodial activity by inhibiting the growth of the chloroquine-resistant *Plasmodium falciparum* strain FCR-3 with EC_{50} values less than 10 µg/ml *in vitro*. the methanol extract of

C. fenestratum with EC_{50} value of 0.5 μg/ml had the strongest antiplasmodial activity. Berberine was found as the major active constituent of *C. fenestratum* extract by activity-guided fractionation. Moreover, methanol extracts of *E. longifolia* and *S. juventas* showed toxicity against mouse mammary tumor cells (Tran et al., 2003).

The inhibiton of angiogenesis is considered to be promising as treatment for some types of cancer. In another study, extracts (aqueous, methanol and methanol-water) from seventy-seven Vietnamese medicinal plants were prepared and tested for their antiproliferative activities against human HT-1080 fibrosarcoma. Among them, extracts from *Caesalpinia sappan* L., *Catharanthus roseus* (L.) G.Don, *C. fenestratum, Eurycoma longifolia* Jack, *Hydnophytum formicarum* Jack and *Streptocaulon juventas* (Lour.) Merr exhibited the effect. Moreover, *H. formicarum* and *S. juventas* showed selective activity against human tumor cell lines, HeLa and A549. Moreover, *C. fenestratum* affected selectively against lung carcinoma and lung metastatic cell lines A549, LLC and B16-BL6 (Ueda JY et al., 2002).

Nguyen-Hai Nam et al. (2003) presented a study where various plant materials were tested for the inhibition of angiogenesis. Some plant materials showed moderate to strong inhibitory activity on the tube-like formation induced by human umbilical venous endothelial cells in vitro. These materials were from *Ephedra sinica* Stapf, *C. pentandra, Coix lacryma-jobi* L., *Drynaria roosii* Nakaike, *Illicium verum* Hook.f. and *Bombax ceiba* L., while the first two listed had the strongest effect.

In another study, 288 extracts of 96 species used in traditional medicine for treating gout and its related symptoms were collected in southern Vietnam and tested for xanthine oxidase inhibitory activity. It´s effect was performed by xanthine inhibitors which blocked the terminal step in uric acid biosynthesis. Among all the extracts, the methanol extract of *Chrysanthemum sinense* proved to be the most active. Strong xanthine oxidase inhibitory activity was exhibited also by extract of *Tetracera scandens* (L.) Merr. and methanol extracts of *A. vulgaris, C. sappan* and *Blumea balsamifera* (L.) DC. (Nguyen et al., 2004).

Bui et al. (2011) carried out a study where thirty two extracts of Vietnamese plants were screened for their inhibitory effect against the ribonuclease H activity of HIV-1 reverse transcriptase and the cytopathic effect of the virus. Eleven extracts from 7 species ihibited over 90 % RNase H enzymatic activity and amongst them the methanol extracts from the leaves of *Phyllanthus reticulatus* Poir. and *Aphanamixis polystachya* (Wall.) R.Parker inhibited RNase H *activity* by 99% and 98%, respectively (Bui et al, 2011).

1.3 Wild edible plants

We could find many wild plants in Vietnamese people´s foodbaskets, because they have nutritional, micronutritional and medicinal benefits (Grivetti and Ogle, 2000). The plants may grow wild in some areas but be protected and managed by farmers or collectors in other regions. Sometimes they can also include agricultural escapees or botanical crossovers (Ogle, 2001). Same as in the case of medicinal plants, women are mostly responsible for collecting wild edible plants and selling them in the market. Therefore the nutritional knowledge, values and beliefs of the caregiving women determine the nutritional contribution of wild plants (Ogle, 2001). The knowledge of wild edible plants enables locals to carry forward culinary traditions, strengthen community relationships with gifts and exchange the plants for transplanting and use (Price, 2000). Collecting those plants brings an opportunity not only to feed the consumption in the household but also to enrich its income (Price and Ogle, 2008). Collecting places can include backyards and fields, also many sites considered as 'in-between spaces' of agricultural landscapes (Rocheleau and Edmunds, 1997), forests, dykes, road sides, common land, water bodies or marsh land. Non-professional collectors and sellers of wild edibles usually gather them during agricultural leisure.

In 1994, the military publishing house of the government published the book "*Wild Edible Vegetables of Vietnam*" (Mot So Rau Dai An Duoc O Viet Nam) which included 128 selected plants and also some specific aspects of military medical crops of Vietnam. (Thompson, 2003) The book reported that there had been over 600 species used as wild vegetables (*Rau Dai)* in the past (Nguyen and Bui, 1994). Although food security has been a major development concern for a long time in Vietnam, the wild edibles are only very slowly becoming more visible in agriculture research. Wild food resources are known to be very useful for example in times of crisis and famine (Scoones et al., 1992). Comparately to wild medicinal plants, wild edibles are recieving very little attention, though there is some interest from FAO, WHO, IDRC, IFPRI and others.

As was already mentioned before, wild edible plants are often intersecting with medicinal plants for their effects. Therefore, the health improvement is an additional function of many wild edibles. During researches many bio-active substances were found, potentially to be used as health-promoter or disease prevention (Craig, 1999; Lampe 1999). Those can be the ones with antioxidant, antimicrobial, antimutagenic and other effects on one´s health (Beecher, 1999; Nakahara et al., 2001).

2. Objectives

The aim of this study is ethnobotanical analysis of literature data on wild plants used for medicinal and/or food purposes in Vietnam. In addition, the study is supported by background data for the study, composed by description of the area studied, Vietnamese traditional medicine, wild edible plants and summary of previous ethnobotanical studies.

3. Materials and methods

A systematic literature review was performed using relevant internet electronic search engines as ISI Web of Knowledge, Scopus, ScienceDirect, PubMed, AGRICOLA, Biological Abstracts, CAB Abstracts and Google Scholar, collecting the data until April 2015. Therefore, the lists of plants reported to be used in the Northern and the Southern were created. Identification of the most frequently used plants among various groups of indigenous people was performed according to the number of records of their use in available, mostly English, literature (Anh et al., 2000; Ogle et al., 2003; Nguyen and Nguyen, 2005; Hoang et al., 2008; Nguyen and Nguyen, 2008; Nguyen and Cho, 2009; Delang, 2012; Hoang, 2012; Sang et al., 2012; Quan et al., 2013; Thoa, 2013; Vo et al., 2014). Medicinal plant with more than four records and edible plants with more than three recordes were selected. To create the tables of chosen plants were used also species with one record less. To determine the correct spelling and reveal synonyms were used web-based databases Tropicos (2015) and The Plant List (2013). The ethnobotanical studies were used, the data came mostly from interviews with common rural people, healers and medicine plants collectors and sellers. In one case, data were from local medicinal plants centre. Searches on documented biological effects of individual plant species *in vitro* and *in vivo* were done. Single constituents derived from plants are not considered herbal medicine themselves and were therefore excluded or just decently mentioned.

In this study, border between the Northern and the Southern Vietnam was set at the Hai Van pass, few kilometres to the north from city Da Nang in province of the same name as it is considered a transition zone of different floras of the Northern and the Southern Vietnam.

4. Results

4.1 Ethnobotanical data

Through a review of literature were identified plant species and created lists of plants. In literature were recoder 361 plant species distributed in 106 families in the Northern Vietnam and used as a wild medicine. Among them, the most abundant species were belonging to the family Leguminosae (26), followed by Compositae (21), Lamiaceae (15), Rubiaceae (12). Numerously represented were also the families Moraceae (11), Apocynaceae (10), Euphorbiaceae (10), Menispermaceae (10), Zingiberaceae (9) and Euphorbiaceae (9).
In the Southern Vietnam were reported 387 plant species among 121 families, used as a wild medicine. The most abundant species were among Compositae (26) and Lamiaceae (20), followed by Leguminosae (18), Zingiberaceae (16), Araliaceae (12), Asparagaceae (12) and Rubiaceae (11).
From the wild edible plants of the Southern Vietnam were recorded 178 plant species among 79 families. Species of highest abundance were from the families Arecaceae (11) and Zingiberaceae (10), followed by Compositae (7) and Moraceae (7).
According to the number of records (at least 4 for medicinal and 3 for edible plants) reporting their use among the people of Vietnam, ten medicinal species (*Cinnamomum cassia, Curcuma zedoaria, Morinda officinalis, Reynoutria multiflora, Oroxylum indicum,* and *Schefflera heptaphylla* from Northern Vietnam and *Passiflora foetida, Piper sarmentosum* and *Scoparia dulcis* from the Southern Vietnam.) and three edible species from the Southern Vietnam (*Centella asiatica, Passiflora foetida* and *Plantago major*) were identified. Those plants are widely used among various spectre of indigenous people in Vietnam. The following tables (Table 2 and Table 3) summarize the results of literature research.

Table 2. Chosen wild medicinal plants from the North Vietnam

Scientific name	Family	Vietnamese name	Parts used	Ailments treated / Uses	Preparations	Sources
Catharanthus roseus (L) G.Don	Apocynaceae	Dừa cạn	Root, stem Root, leaf Root Leaf	High blood pressure Indigestion Dysentery Irregular menses	Decoction Decoction Decoction	1,2,6
Homalomena occulta (Lour.) Schott	Araceae	Thiên niên kiện	Tuber	Weakness, cough		1,2,4
Schefflera heptaphylla (L.) Frodin	Araliaceae	Chân chim	Leaf, bark Leaf Root Bark	Itches Urinating problems, weakness Indigestion	Crushed and applied externally Tonic/cooked	1,2,3,4
Asparagus cochinchinensis (Lour.) Merr	Asparagaceae	Tóc tiên	Root Leaf	Cough, fever, tuberculosis Snakebite		1,2,6
Oroxylum indicum (L.) Kurz	Bignoniaceae	Núc Nác	Bark, fruit Bark Bark	Strained muscles Dysentery, allergies, stomachache, chronic cough Ulcers	Decoction Decoction Powder	1,2,5,6
Artemisia vulgaris L.	Compositae	Ngải cứu	Leaf Leaf Stem, Leaf	Headache Weakness after childbirth Risk of miscarriage	Juice Cooked Juice with salt or sugar	1,2,5
Blumea balsamifera (L.) DC.	Compositae	Đại bi	Leaf Stem	Cough, cold, flu Stomachache	Decoction Decoction	1,2,5

Xanthium strumarium L.	Compositae	Ké đầu ngựa	Stem, leaf, root Leaf Fruit	Dysentery Itches	Decoction Chewed raw and applied	1,2,5
Dioscorea hamiltonii Hook.f.	Dioscoreaceae	Củ mài	Root	Fever, indigestion, testinal inflamation, cholera	Tonic	1,2,6
Eleutherine bulbosa (Mill.) Gagnep.	Iridiaceae	Sâm đại hành	Bulb	Weakness, indigestion		1,2,3
Cinnamomum cassia (L.) J.Presl	Lauraceae	Quế	Bark Bark Leaves	Indigestion Stomachache	Chewed raw and swallowed Pounded with honey and given with cold water	1,2,3,6
Cinnamomum iners Reinw. ex Blume	Lauraceae	Re hương	Bark Bark		Chewed raw and swallowed Pounded with honey and given with cold water	1,2,5
Abutilon indicum (L.) Sweet	Malvaceae	Cối xay	Leaf, fruit, twig	Fever, flu	Decoction	1,2,5
Fibraurea recisa Pierre	Menispermaceae	Hoàng đằng	Stem Stem Stem, root	Wounds Rheumatism Weakness	Crushed and applied Tonic Decoction from small pieces	1,2,4
Stephania rotunda Lour.	Menispermaceae	Củ bình vôi	Tuber	Stomachache, cold	Decoction	1,2,4

Artocarpus tonkinensis A.Chef. ex Gagnep.	Moraceae	Chay	Bark, fruit	Toothache		1,2,3
Anoectochilus roxburghii (Wall.) Lindl.	Orchideacea	Kim tuyến	Whole plant	Weakness	Tonic	1,2,5
Pandanus tonkinensis Martelli ex B.C.Stone	Pandanaceae	Dứa	Fruit	Sunburn		1,2,3
Reynoutria multiflora (Thunb.) Moldenke	Polygonaceae	Hà thủ ô đỏ	Root	Weakness after childbirth / Blood faster, keeps youngness and black hair	Tonic	1,2,3,5,6
Morinda officinalis F.C.How	Rubiaceae	Ba kích	Root, stem Root	High blood pressure Spermatorrhoea, rheumatism, irregular menses / Aphrodisiac		1,3,5,6
Clausena excavata Burm.f.	Rutaceae	Hồng bì dại	Leaf, fruit	Stomachache		1,2,3
Melicope pteleifolia (Champ. ex Benth.) T.G. Hartley	Rutaceae		Leaf	Measles		1,2,3
Stemona tuberosa Lour.	Stemonaceae	Bách bộ	Tuber			3,4,5
Styrax tonkinensis (Pierre) Craib	Styracaceae	Bồ đề	Leaf, resin	Pneumonia		1,2,5
Pouzolzia zeylanica (L.) Benn.	Urticaceae	Bọ mắn	Whole plant Leaf	Tuberculosis / Clears digestion Infection		1,2,6

Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae	Nghệ đen	Root	Stomachache	1,2,3,5

(1) Hoang VS et al., Blumea. 53 (2008) 569-601; (2) Hoang VS, Tap Chi Sinh Hoc. 34 (2012) 82-87; (3) Delang CO, Econ. Bot. 59 (2012) 377-385; (4) Nguyen TKT and Nguyen NT, VNU Journal of Science. Nat., Sci. & Tech. 21 (2005) 125-129; (5) Nguyen DNV and Nguyen T, An overview of the use of plants and animals in traditional medicine systems in Viet Nam (2008); (6) Anh DQ et al., Indigenous agricultural Knowledge of ethnic minorities in upland area of Yen Bai province – Vietnam (2000); (7) Vo VM et al., J. Med. Plants Res. 2 (2014) 64-71.

Table 3. Chosen wild medicinal plants from the South Vietnam

Scientific name	Family	Vietnamese name	Parts used	Ailments treated / Uses	Preparations	Sources
Centella asiatica (L.) Urb	Apiaceae	Rau má	Whole plant			1,3,4
Lasia spinosa (L.) Thwaites	Araceae	Chóc gai	Root			1,4,6
Lactuca indica L.	Compositae	Bồ công anh Việt Nam	Stem, leaf	Skin diseases		1,2,3
Cheilocostus speciosus (J.Koenig) C.D.Specht	Costaceae	Mía dò	Root			1,3,6
Cibotium barometz (L.) J.Sm.	Cibotiaceae	Lông cu li	Root			1,3,4
Senna tora (L.) Roxb.	Leguminosae	Thảo quyết minh	Stem, seed	Dysuria / Cooling agent, sedative		1,2,3
Erythrina variegata L.	Leguminosae	Vông nem	Branch, leaf			1,3,4
Mimosa pudica L.	Leguminosae	Cây xấu hổ	Whole plant	Backache / Sedative, antidote		1,2,3
Passiflora foetida L.	Passifloraceae	Lạc tiên	Whole plant	Insomnia / Sedative		1,2,4,6
Piper sarmentosum Roxb.	Piperaceae	Lá Lốt	Whole plant	Backache		1,2,3,4,5
Plantago major L.	Plantaginaceae	Mã đề	Leaf			3,4,5
Scoparia dulcis L.	Plantaginaceae	Cam thảo nam	Whole plant	Skin and liver diseases		1,2,4,6

Houttuynia cordata Thunb.	Saururaceae	Diếp cá	Leaf	Diabetes, liver diseases, intervertebral disc / Sedative	1,3,5
Smilax glabra Roxb.	Smilaceae	Thổ phục linh	Tuber	Stomach problems, coughing up blood	1,2,3
Curcuma zedoaria (Christm.) Roscoe	Zingiberaceae	Nghệ đen	Tuber		1,2,3

(1) Nguyen DNV and Nguyen T, An overview of the use of plants and animals in traditional medicine systems in Viet Nam (2008); (2) Vo VM et al., J. Med. Plants Res. 2 (2014) 64-71; (3) Nguyen VK and Cho JH, Korean J Plant Resour. 22 (2009) 571-583; (4) Ogle BM et al., Econ. Bot. 57 (2003) 103-117; (5) Sang DT et al., Asian Journal of Biodiversity (AJOB). 3 (2012) 23-49; (6) Quan TTB et al., Medicinal Plants Locally Used By the Chau Ro At Dongnai Culture and Nature Reserve (2013).

Table 4. Chosen wild edible plants from the South Vietnam

Scientific name	Family	Vietnamese name	Parts used	Uses	Sources
Alternanthera sessilis (L.) R.Br. ex DC.	Amaranthaceae	Rau Dệu	Leaf, stem	Vegetable, feed	2,3
Amaranthus viridis L.	Amaranthaceae	Dền xanh	Leaf, stem	Vegetable	1,3
Centella asiatica (L.) Urb.	Apiaceae	Rau má	Whole plant	Vegetable, medicine, feed	1,2,3
Oenanthe javanica (Blume) DC.	Apiaceae	Cần nước	Green parts	Vegetable, medicine	2,3
Colocasia esculenta (L.) Schott.	Araceae	Khoai	Tuber, petiole	Boiled vegetable, medicine	2,3
Calamus tetradactylus Hance	Arecaceae	Mây nếp	Top, shoot	Vegetable	2,3
Caryota mitis Lour.	Arecaceae	Đủng đỉnh	Shoot, inside stem	Vegetable	2,3
Diplazium esculentum (Retz.) Sw.	Athyriaceae	Rau dớn	Young leaf	Vegetable	1,3
Ageratum conyzoides (L.) L.	Compositae	Cây cứt lợn	Young leaf	Vegetable, medicine, feed	1,3
Emilia sonchifolia (L.) DC. Ex DC.	Compositae	Rau má lá rau muống	Leaf, stem	Vegetable	1,3

Crassocephalum crepidioides (Benth.) S.Moore	Compositae	Rau tàu bay	Leaf, stem, shoot	Vegetable, feed	2,3
Dioscorea hamiltonii Hook.f.	Dioscoreaceae	Củ mài	Tuber	Boiled vegetable, medicine	2,3
Hibiscus surattensis L.	Malvaceae	Bụp Xước	Leaf	Vegetable	1,2
Passiflora foetida L.	Passifloraceae	Lạc tiên	Young leaf, fruit, shoot, top	Boiled or raw vegetable, medicine, feed	1,2,3
Peperomia pellucida (L.) Kunth	Piperaceae	Rau càng cua	Leaf, stem, top	Vegetable	1,2
Piper sarmentosum Roxb.	Piperaceae	Lá Lốt	Leaf	Vegetable, spice, medicine	2,3
Plantago major L.	Plantaginaceae	Mã đề	Leaf	Vegetable, medicine	1,2,3

(1) Thoa PTK, Journal of Research in Environmental Science and Toxicology (JREST). 2 (2013) 167-174; (2) Sang DT et al., Asian Journal of Biodiversity (AJOB). 3 (2012) 23-49; (3) Ogle BM et al., Econ. Bot. 57 (2003) 103-117.

5. Discussion

Cinnamomum cassia is one of the world´s oldest natural spices, commonly used in traditional oriental medicine. Dried seeds, fruit, root, bark and vegetative substances are used for different purposed. The spice has its place in medicine, cosmetics, religious rituals, as vegetable, as well as in the perfumery, pharmaceutical and cosmetical industry (Vangalapati et al., 2012). The most usually used species can be differentiated into the cassia cinnamon and ceylon cinnamom. Cassia cinnamons are *C. cassia* and *C. burmannii* (Nees & T.Nees) Blume, from them is consumed just inner bark. Ceylon cinnamon or the „true" cinnamon is *C. verum* J.Presl, it has different flavor and both, thick outer and the thin inner bark can be used (Vangalapati et al., 2012). In literature can be sometimes seen, that both *C. verum* and *C. cassia* bark are collectively alled *cortex cinnamoni*, although they have different taste and smell (Ooi et al., 2006). The *C. cassia* cortex and sprouts contain essential oil with a content of cinnamaldehyde, phenolic compounds, polysaccharides, tannins, calcium oxalate, biotin, coumarins and others. In traditional medicinal systems is used among others against urinary and digestive disorders, impotency and pain, especially the one connected with menstruation. Sprouts are used to treat cold, fever and rheumatism. Chinese Traditional Medicine restricts it´s use together with Allium spp. and kaoline (Valíček, 2009).

C. cassia is known for its wide antimicrobial activites. In a study of Sharma et al. (2009) on chosen medicinal plants antimicrobial effects on major urinary tract pathogens, ethanol extract exerted strong activity against *P. aeruginosa*. Oil from *C. cassia* was found to be effective inhibitor of growth of bacteria *Escherichia coli, Enterobacter aerogenes, Proteus vulgaris, P. aeruginosa, Vibrio cholerae, V. parahaemolyticus, Salmonella typhymurium* and *S. aureus,* and fungi *Candida albicans, C. tropicalis, C. glabrata, C. krusei, Microsporum gypseum, Trichophyton rubrum and T. mentagraphytes* and Fusarium sp. The results suggested that the antimicrobial effectivity of the plant is due to cinnamaldehyd (Ooi et al., 2006) In other study, *C. cassia* showed activity against *C. albicans in vitro*, and also in oral cavity *in vivo*. Therefore it could be used as a treatment against murine oral candidiasis (Taguchi et al., 2010).

Numerous studies evaluated possible use of *C. cassia* against food spoilage. Essential oil from *C.cassia* showed a strong antimicrobial activity against *Pseudomonas putida in vitro* (Oussalah et al., 2006). Extract from *C. cassia* exhibited antimicrobial activites against

Bacillus cereus, S. aureus, Listeria monocytogenes, E. coli and Salmonella infantis (Alzoreky and Nakahara, 2003). The oil showed also good antifungal activity against *Aspergillus flavus.* Therefore *C. cassia* could possibly provide potential antimicrobial agents to inhibit spoilage growth in food (Rajkovic et al., 2015).

Potent nematicidal activity of *C. cassia* oil was also observed, it was found toxic to *Bursaphelenchus xylophilus* by a direct contact bioassay (Kong et al., 2007).

C. cassia has also anti-inflammation potential. The bark extract showed ihibitory effects on nitric oxide production in mouse leukaemic monocyte macrophage cell line (Lee et al., 2002). In another study, *C. cassia* extract exerted potent inhibition of cycloogenase-2 activity in lipopolysaccharide-induced mouse macrophages cells (Hong et al., 2002). Akira et al. (1986) published study on anti-ulcer activity of the plant, where the aqueous extract prevented occurence of stress ulcers under exposure to cold temperatures and on restraint of water in rats. Moreover, it strongly inhibited gastric ulcers induced by a subcutaneous injection of serotonin.

Moreover, *C. cassia* extracts exerted significant antimutagenic effects as a pretreatment against benzo[a]pyrene and cyclophosphamide in rats (Sharma et al, 2001). *C. cassia* aqueous extract reduced migration potential in cervical cancer cells. It also significantly reduced the expression of Her-2 oncoprotein and induced apoptosis of the cells (Koppikar et al., 2010).

Cinnamomum spp. were reported to posess great anti-diabetic potential. *C. cassia* and *C. verum* were assessed for their anti-diabetic effects *in vivo* and *in vitro*. Extracts from both species and *C. cassia* bark increased the plasma insulin and decreased the blood glucose level in rats. Effect of *C. cassia* was found stronger than of *C. verum*. Moreover, *C. cassia* extract had stimulative effect on insulin releasing activity *in vitro* (Verspohl et al., 2005). In a study of Kim et al. (2006), *C. cassia* extract was tested in type II diabetic mice and it significantly decreased the blood glucose concetration. Moreover, the concentration of triglyceride, total cholesterol and intestinal alpha-glycosidase activity got significantly lower and serum insulin levels and HDL-cholesterol levels got higher.

The plant was also reported to possess hepatoprotective activity *in vitro* and *in vivo*. In a study of Lim et al. (2009), *C. cassia* ethanol extract reduced the expression of alpha-smooth muscle actin, connective tissue growth factor, transforming growth factor beta 1 and tissue inhibitor of metalloproeinase-1 hepatic stellate cells. *C. cassia* powder had significant effect on recovery of the serum total protein, albumin, total-bilirubin, direct-bilirubin, glutamic

oxaloacetic, transaminase, glutamic pyruvic transaminase and alkaline phosphatase in rats with acute liver injury induced by dimethylnitrosamine.

Study of Zhao et al. (2006) investigated the hypouremic effects of *C. cassia* oil. It lowered serum and hepatic uric acid levels in normal and hyperuremic mice. The oil also showed ihibitory activity actions against liver xanthine dehydrogenase and xanthine oxidase activities *in vivo*. Therefore, *C. cassia* could be possibly used as treatment of gout.

Premanathan et al. (2000) presented a study on effects of medicinal plants on human immunodeficiency virus induced cytopathogenicity *in vitro*. Of the 69 plant species screened, *C. cassia* bark was among the most effective against both, HIV-1 and HIV-2.

The plant was also tested for protective effect against neuronal death. *C. cassia* water extract significantly protected against glutamate-induced cell death and also inhibited glutamate-induced influx (Shimada et al., 2000).

Additional, *C. cassia* formulations of oil in sprays and oil-based fumigant were found effective against *Dermatophagiodes fariane* and *D. pteronyssinus*, using contact and vapour-phase toxicity assays (Kim et al., 2008).

Curcuma zedoaria has been traditionally used and cultivated between the South and the East Asia as a vegetable and spice with medicinal effects (Lobo et al, 2009). It is one of the plants from genus Curcuma used in Asia, other common species are *C. longa* L., *Curcuma zanthorrhiza* Roxb. *or C. angustifolia* Roxb. (Valíček, 2010). Curcruma spp. were reported to contain essential oils (e.g. zingiberen, turmerones), water-soluble peptide turmerin and phenolic comounds curcuminoids (Aggarwal et al., 2003). The rhizome of *C. zedoaria* is used in Chinese and Japanese folk medicines as an aromatic stomachis, stimulant, diuretic, carminative, anti-diarrheal and anti-emetic. It is also used as treatment for wounds, ulcers and skin diseases (Matsuda et al., 2001). In Southeast asia, the plant´s dried rhizome has been used as medicinal extract or as a drink treating among others rheumatism and coryza, also possessing antimicrobial, anti-inflammatory, neuroprotective and hepatoprotective activity . Sometimes it is used as a substitute of *C. longa* for treatment of itching, as *C. zedoaria* is among Zingiberaceae with anti-allergic effects (Stanly et al., 2010).

C. zedoaria was tested for antimicrobial activity against bacteria and fungi. Its extracts exhibited significant inhibitory activity against *B. subtilis, Micrococcus luteus, Proteus mirabilis, Klebsiella pneumoniae, C. albicans* and *A. niger*. On the other hand, *E. coli* and *S.s aureus* growth was not inhibited (Wilson et al., 2005). Ethanol extract from rhizome of *C.*

zedoaria exhibited antifungal activity against human pathogenic fungus *in vitro*. It showed inhibitory activity against yeast-like (*C. albicans, Cryptococcus neoformans, Saccharomyces cerevisiae, Wangiella dermatitidis*) and filamentous (*Microsporum gypseum, Pseudallescheria boydii, Trichophyton mentagrophytes)* fungi (Ficker et al., 2003). Alcoholic extract from *C. zedoaria* showed some antiamoebic potential when inthibited growth of *Entamoeba histolytica* (Ansari and Ahmad, 1991).

Moreover, extract from *C. zedoaria* exhibited potent analgesic activity in several models of pain in mice. Curcumenol was found to be responsible for this activity. (Navarro et al., 2002) Anti-nociceptive effect of the plant was tested as well, dichlormethane extract obtained from mother rhizome were given to mice with acetic acid-induced abdominal constriction. The extract caused considerable activity, inhibiting over 90 % of the constrictions (Pamplona et al., 2006). Essential oil from dried rhizome showed antioxidant activities including an excellent scavenging effect on DPPH radicals (Mau et al., 2003).

As a one of 12 plants used in traditional Thai remedy preparation for cancer treatment, *C. zedoaria* extracts were tested for cytotoxic activity. Ethanolic extract showed cytotoxic activity against large cell lung carcinoma and prostate cancer cell lines. Less cytotoxic activity was exerted against normal human fibroblast. On the other hand, water extract did not exhibit any activity in this study (Saetung et al., 2005). The plant may also play an important role in inhibition of cancer metastasis. Water root extract was given mice before tumor inoculation. The results indicated that the extract possess anti-migratory effects on B16 melanoma cells and modulates macrophage function positively (Seo et al., 2005). In another study, chosen Chinese medicinal were tested for possible antimutagenic acitivy. Among them, *C. zedoaria* water extract made from root by boiling it in water for 2 hours, which is commonly used method used by Chinese people, was found to possess moderate activity against benzo[α]pyrene (Lee and Lin, 1988).

Water extract from rhizome of *C. longa* or *C. zedoaria* has been used in Japan as a protection against drunkeness and treatment the lost of appetite and nauzea induced by alcohol consumation. Therefore, Kimura et al. (2013) investigated study on this topic and found that extract reduced the elevation in blood alcohol concentrations. This was done probably by curcumenone, which alone as well as the extract increased liver alcohol dehydrogenase activity.

In the Unani medicine is *C. zedoaria* used for treatment of peptic ulcer. Root of *C. zedoaria* was found effective against hyperacidity and gastric ulcers. Tested in pyloric-ligated

rats, the root powder reduced the gastric pH, free acid, total acid and ulcer index (Raghuveer et al., 2003). *C. zedoaria* was found to possess hepatoprotective effects. Water extract from *C. zedoaria* was examined on the growth inhibition of hepatic myofibrioblast cells (hMF) outgrowth from human liver. Proliferation of these cells is known to be central for the development of fibrosis during liver injury, and hepatic fibrosis is the main symptom of chronic liver disease. Results showed that *C. zedoaria* could be used against this disease, because the water extract potently inhibited the hMF growth (Kim et al., 2005).

Aqueous extract of *C. zedoaria* also showed some inhibitory action against cobra venom by binding of anti-cobra venom antibody. Therefore it can have potential as antivenom (Daduang et al., 2005).

Moreover, steam-distillated oil from *C. zedoaria* exerted significant larvicidal potential against the vector of malaria *Aedes aegypti*, and the vector of dengue fever *Anopheles dirus*. Active ingredients of *C. zedoaria* could be used in development of effective mosquito larvicides (Pitasawat et al., 2007).

Morinda officinalis is a liane with fleshy roots. It grows in the South and the Southeast Asia along fields, bodies of water or in sparse forests (Valíček, 2009). The genus Morinda includes around 20 species with a great value, economical or other (Morton, 1992). Unlike its well-known relative Noni (*M. citrifolia* L.), just roots and sometimes stem is used. The root has no odour and sweet and slightly sour taste. Among its active compounds are saccharides and monotropein, an iridoid glucoside, of the greatest medicinal use (Valíček, 2009).

M. officinalis is known to have protective and antidepressant effects. Study investigating theses effects of showed that *M. officinalis* extract significantly reduced response rate and efficiency ratio in tested rats (Zhang et al., 2002). In a study dealing with protective antioxidant effects of *M. officinils* showed *morindae radix* high efficiency. Tested on the cultured mouse cells exposed to H_2O_2-induced oxidative stress, it increased the cell viability with decreased lipid peroxidation level, increased testosterone production, and improved superoxide dismutase and catalase activity *in vitro* (Chang et al., 2008).

Another study investigated effect of long term administration of *M. officinalis* on strength and stamina. Water soluble extracts increased both and showed anti-fatigue effect in mice (Jin et al., 2008). Qiao et al. (1991) compared effects of different medicinal plants, results showed that *M. officinalis* extract had the anti-fatigue effect, improved the

immunological action of the young mice and reduced the excitability of the para-sympathetic nervous systém of the hypothyroidism mice (Qiao et al., 1991).

Bone-protective effect is one of the main *M. officinalis* qualities in traditional medicine. Study aimed on bone-protective effects of *M. officinalis* was investigated on ovariectomy-induced bone loss in rats. Ethanolic extract from the roots increased trabecular bone mineral content and bone mineral density of tibia, improved the levels of phosphorus, calcium and osteoprotegerin and decreased the levels of tartrate-resistant acid phosphatase, adrenocorticotropic hormone and corticosterone. However, the study also showed that *M. officinalis* treatment is not involved with bone formation (Nan Li et al., 2009). In another study, Li et al. (2014) found it also an effective treatment for osteoporosis. Female rats with postmenopausal osteoporosis induced by bilateral ovarioectomy were divided into groups. Group of rats treated with the Morinda officinalis capsule, showed the ability of the capsules at all doses to prevent the induced loss of bone mass. The capsules also enhanced bone strength and prevented the deterioration of trabecular microarchitecture.

The anti-inflammatory effects were examined as well, using rats with carrageenan-induced edema model. The antinociceptive effects were assessed in mice using the acetic acid-induced abdominal constriction test and the hot-plate test. Menthanol extract from *M. officinalis* roots exhibited anti-inflammatory and antinociceptive effects in these animal models. The extract showed anti-inflammatory and antinociceptive activity, inhibiting inducible nitric oxide synthase, cyclooxygenase and tumor necrosis factor-alpha expression by down-regulating NF- κB binding activity (Kim et al., 2005).

In a study on the antiglycemic effects, ethanolic extract reduced the fasting serum glucose levels of the diabetic rats significantly at the dose of 150 mg/kg. But after dose of 600 mg/kg, the glucose levels were increased. It showed that *M. officinalis* possesses hypoglycemic or hyperglycemic effect dependently on the dose (Soon and Tan, 2002).

M. officinalis extracts were also examined for the anticonvulsive effect. Methanol extracts significantly inhibited the convulsion state and limited the level of lipid peroxidation in the brain in pentylenetetrazol-induced convulsive mice. (Heo and Choi, 2013).

One study compared efficiency of products made from *M. officinalis* on symptoms of the kidney-Yang deficit mice. All products showed ability to tonify kindeys and support Yang deficit. Among them, salt-steamed preparation had the most significant effect, followed by morinda pulp, licorice-processed *M. officinalis*, and unprocessed M. officinalis (Cui et al., 2013).

Oroxylum indicum is a tree native to the Indian subcontinent, nowadays growing in tropical and subtropical low-altitude openforests of whole South and Southeast Asia. It is also cultivated along roads and on slopes (Kochummen, 1978). Therefore it is used as a medicinal herb in many Asian countries. It has diverse range of recorded traditional uses. The stembark and root treats among others fever, bronchitis, intestinal worms, asthma, inflammation, diarrhea and dysentery, The fruit and seeds are used as purgative and expectorant bitter tonic (Kirtikar and Basu, 1996). On the other hand, in Ayurvedic medicine the root bark, stem and leaves are used against snakebite and digestion problems (Ghani, 1998). Chinese medicine treats cough, bronchitis and other respiratory problems with the *O. indi*cum seeds. (National Commission of Chinese Pharmacopoeia, 2010). The main active compounds are thought to be baicalin, baicalein, chrysin (Singh and Kakkar, 2013), oroxylin-A, lapachol and their derivates (Siriwatanametanon et al., 2010).

Kumar et al. (2010) published a study dealing with antioxidant activity *of O. indicum.* The aqueous and methanolic extracts exhibited considerable free radical scavenging and ferric reducing abilities *in vitro*. They also showed moderate levels of DNA protection against oxidative stress (Kumar et al., 2010). In study of Siriwatanametanon et al. (2010), extracts showed high level of antioxidant activity *in vitro* by inhibiting lipid-peroxidation and release of IL-1β and PGE2. It also showed NF-κB inhibitory effects with low IC_{50} values, which indicates anti-inflammatory potential. In a study presented by Laupattarakasem et al. (2003) were tested four medicinal plants *in vitro* for the effects relevant to anti-inflammatory activity. Among them, aqueous extract of *O. indicum* stembark significantly reduced myeloperoxide release (Laupattarakasem et al., 2003). In another study, extracts of root bark exhibited anti-arthritic activity in Freund's complete adjuvant-induced arthritis rats. The extracts reduced rats paw volume. Hematological parameters such as hemoglobin and red blood cells showed a significant increase, while there was decrease in the total white blood cells count and erythrocyte sedimentation rate (Karnati et al., 2013). The plant methanolic extract also exhibited some wound-healing activity when treated partial thickness burn wounds in mice (Singh et al., 2011). *O. indicum* is known to have analgesic effects. Extracts from the root bark showed strong analgesic effects *in vivo* in rats evaluated with various assays (Asaduzzaman et al., 2011).

One of indigenous uses of this plant is treatment of diarrhea caused by inflammation in bowel. Anti-diarrheal activity was exerted by methanol extract of the stem bark. It showed

significant *in vivo* anti-diarrheal activity prolonging the onset of diarrheal episodes and reducing the number of stools in a castor oil-induced diarrhea model in mice (Asaduzzaman et al., 2011). In other study, *O. indicum* shows also some anti-ulcer effects, extracts of its stem bark exerted mild to moderate gastroprotective activity in ulceration induced by pylorus ligation, cold-restraint, ethanol and aspirin (Khandhar et al., 2006). In another study, aqueous extract of the root bark exerted significant anti-colitis effect in dinitrobenzene sulfonic acid-induced colitic inflammation and injury in rats (Joshi et al., 2011).

O. indicum possesses also antimicrobial activities. Dichloromethane extracts of stem bark and root exerted antimicrobial effect against bacteria *B. subtilis, S. aureus, Pseudomonas aeruginosa* and fungus *C. albicans* in the disc diffusion assay (Ali et al., 1998).

Study assessing anticancer potential of folk Banglaseshi medicinal herbs included *O. indicum* extract. It showed cytotoxic activity against murine melanoma, human colon carcinoma, lymphoblastic leukemia and leukemia tumor cell lines, therefore *O. indicum* can be considered as a potential source of anticancerous compounds (Costa-Lotufo et al., 2005). In another study, *O. indicum* extract exhibited high cytotoxicity against HeLa cells (Siriwatanametanon et al., 2010).

O. indicum was found to have some imunnostimulant properties. The powder from stem bark and root bark exhibited significant humoral and cell-mediated immune response in broiler chickens (Kumari et al., 2011).

Other study reported that methanolic extract of the seeds exerted significant anti-gout activity in xanthine oxidase inhibiton assay *in vitro* (Li et al., 2014). Another study was aimed to assess antihyperglycemic activity of *O. indicum* extract *in vitro* and *in vivo* in rats. Besides strong antioxidant capacity was showed potential to inhibit bovine serum albumin glycation and α-glucosidase activity. It also showed that the extract has capacity to significantly enhance the insulin sensitivity (Singh and Kakkar, 2013). Another study was dealing with the plants hepatoprotective activities, More et al. (2013) published a study, where aqueous and ethanolic extracts of *O. indicum* showed significant hepatoprotective activity in rats with hepatic injury induced by paracetamol. *O. indicum* is also used as treatment to urinary disordes, Sreedevi et al. (2011) investigated its nephroprotective effect in rats with cisplatin-induced renal injury. The ethanolic extract of the roots significantly restored all assesed parameters to normal (e.g. blood urine nitrogen, serum creatine and urinary total proteins). In another study, ethanol extracts of *O. indicum* fruit was found effective in radioprotective

effects on DNA against γ radiation-induced damage in rat bone marrow cells *in vivo* (Thokchom et al., 2014).

There were also many studies conserning toxicity of the plant, but the results did not show increased mortality or behavioral changes *in vivo* in both, short or long term administration (Thokchom et al., 2014; Tamboli et al., 2011).

Reynoutria multiflora (syn. *Polygonum multiflorum*) is is one of very popular plants used in China to treat diseases associated with aging. It is part of many medicines and prescription, also used as powder, decoction or infusion. The root is commonly processed by steaming with black Bean (Zhou, 2010), rehmania juice, or a mixture of black beans with ginger or wine (Committee on the programming teaching material for higher TCM education, 1996). In Chinese traditional books and prescriptions it is used as liver and kidney tonic, against aiging, tratment of carbuncles, scrofula, postpartum, morbid lecorrhea (Lin et al., 2015), sore scabies, ringworm and pruritus (Lan, 1959). The Traditional medicine restricts its use together with genus Allium spp. or *Raphanus sativus* as well as with fishes, blood and products made from blood. In the preparation also must not be used iron (Valíček, 2010).

The root has the highgest content of active compounds, the anthraquinones are of the highest activity but there are many others as stilbenes, tannins, naphtalenes, flavonoids and phospholipids (Lin et al., 2015).

In a group of 30 tested traditional Chinese medicinal plants was the antioxidant activity of *R. multiflora* root and stem extract among the highest. It contains lot of phenolic contents and therefore it could be potentional source of natural atioxidants (Wong et al. 2005). In other study, *R. multiflora* ethanol extract exerted anti-aging effects in D-galactose-induced subacute aging mice (Song et al., 2003). It could possibly have some potential in treating Alzheimer´s disease (Lin et al., 2015). *R. multiflora* is also considered traditional herb in the whole East Asia for treating patients suffering from hair loss and baldness. Extract was tested in mice and increased number and the size of hair folicles were observed. It promoted hair the growth through inducing anagen phase in resting folicles (Parka et al., 2011).

The aqueous extract of *R. multiflora* attenuated significantly the apoptopic damage on vascular endothelial cells under ischemic and inflammatory conditions. On the other hand, it inhibited the DNA synthesis and the cell growth, which may weaken the ability of endothelial repair (Ling et al., 2008). The cerebrovascular protective effect was shown in study of Lee et al. (2014). Extracts from *R. multiflora* exerted protective action against focal photothrombotic

ischemic brain injury, it induced a significant reduction in infarct volume and subsequent neurological deficits in mice (Lee et al., 2014).

Findings of a study investigating neuroprotective effects of the plant suggested that the extract had beneficial influence on parkinsonism (e.g. significantly attenuating the impairment of behavioral performance) (Xia Li et al., 2005). In another study, neuroprotective effects of *R. multiflora* ethyl acetate extract were investigated against glutamate-induced oxidative cell death in HT22 hippocampal cells and the pretreatment with the extract decreased glutamate-induced neurotoxicity and resulted in radically inhibited glutamate-induced apoptotic and necrotic neuronal death (Kim et al., 2013). The plant has also some acetylcholinesterase inhibition potential. Acetylcholinesterase inhibitiors are commonly used to treat Alzheimer disease. Lin et al. (2008) published study which demostrated that R. multiflora extracts can treat brain function disorders and insomnia by inhibition the activity of AChE *in vitro*.

There are many studies and reports dealing with toxicity of *R. multiflora*. The most frequently reported hepatic adverse effect was acute toxic hepatitis, while vision problems, dyspnea, palpitations, fever, rash and abdominal pain can occur also (Murray et al., 2008; Navarro and Senior, 2006). Its compounds contributing to the toxicity against human hepatocytes are thought to be emodin, physcion, emodin-8-O-β-D-glucopyranoside and physcion-8-O-β-D-glucopyranoside (Lv et al., 2015). Studies showed that the toxicity depends on preparation, which changes the contents of the components. Processing showed significant decrease in toxicity of raw *R. multiflora* (Xiaoqing Wu et al., 2012). Water extracts were found to be less toxic than others (Lv et al., 2015; Jie Yu et al., 2011). Ethanol extract of *R. multiflora* had some toxic effects on human hepatocytes L-02 cells while the aqueous extract did not show any toxicity. Ethanol extract also exhibited inhibiton on the proliferation of L-02 cells. In contrast, water extracts obviously promoted the cell proliferation (Lv et al., 2015). Noda et al. (2009) published study, where hot water extract of *R. multiflora* not only didn't induce hepatotoxicity in mice, but also had beneficial effects on their livers. Moreover, in other study, extract of *R. multiflora* attenuated liver damage by reducing lipid peroxidation (Lee et al., 2012).

R. multiflora rhizome can be used as antibacterial treatment, it showed activity against pathogenic isolates of methicillin-resistant *Staphylococcus aureus* (Zuo et al., 2008).

The plant is more often applied as mixed remedy than a single herb. *Quishu* decoction was made from seven plants including *R. multiflora.* Its effects on treatment of non-small-cell lung carcinoma patients with leukopenia after chemotherapy were investigated. The resulsts

suggessted that *Quishu* greatly improved bone marrow depression, recovered leukocytes and promoted blood-producing functions, bringing benefits to the patiens (Xiang and Han, 2013).

Schefflera heptaphylla (syn. *S. octophylla*) is critically endangered specie of tree, used for its medicinal effects. Moreover, it has timber of high quality (Yang et al., 2009). The genus Schefflera possesses various ethnomedicinal uses including treatment of arhritis, rheumatism, stomach pain, astma and liver diseases (Ragasa and Lik, 2005). In Indochina, the leaves of *S. heptaphylla* are considered diuretic, (Nguyen, 1993) while in the Southern China, it is widely used as a main ingredient of the popular health tea formulation against cold and common infections (Li et al., 2009). In a study published by Li et al. (2007), extract from leaves of *S. heptaphylla* exerted potent antiviral activity against respiratory syncytial virus. Essential oil from the plant showed significant antiproliferative activity against breast cancer, malignant melanoma, and liver hepatocellular cells.

Passiflora foetida is perennial creeping wine native to the Southern USA, Mexico, Central America, the Caribbean and South America. It has widely naturalized in many tropical regions of the world including Vietnam (Patil et al., 2014). The genus Passiflora contains hundreds of species, most of them are naturally distributed in the warm temperate and tropical regions of the New World, while less species is indigenous to Asia, Australia and Africa. Several of them are collected or grown for edible fruits, most commonly *Passiflora edulis* (McGuire, 1999). *P. foetida* has developped an interesting technique to protect its fruits. Bracts, which grow along with and cover the buds and fruits, has numerous small glands slowly producing sticky secretion, which contains digestive enzymes. It significantly decreases predator damage to the plant (Radhamani et al., 1995). The plant contains various chemical compounds such as tannins, alkaloids, phenolic compounds and flavonoids (Linga et al., 2014). *P. foetida* has numerous uses in folk medicines in many countries. Infusion made of the leaves traditional treatment of hysteria and insomnia in Nigeria (Nwosu, 1999). In India, it is widely cultivated, and the leaves are used against headache and gidiness. Decoction treats asthma and digestive disorders. The fruit is used as emetic (Kirtikar and Basu, 1975). In La Reunion, it is considered emmenagogue and in Brazil, it is used against erysipelas and skin diseases with inflammation (Chopra et al., 1944). In Vietnam, the leaves are used for making tea, which vanishes sleeping and nervous disorders (Patil et al., 2014).

In a study on antibacterial effect of *P. foetida in vitro*, methanol extract of roots exhibited strong activity against *Klebsiella pneumoniae*, *P. aeruginosa* and *E. coli* (Baby et al., 2010). In another study, extracts from *P. foetida* exerted antibacterial activity against human patogens *Pseudomonos putida, Vibrio cholerae, Shigella flexneri* and *Streptococcus pyogenes in vitro.* Leaves extracts were found to have remarkably higher effect than fruit extracts (Mohansundari et al., 2007).

P. foetida ethanolic and aqueous extracts were found to possess antioxidant acitivities. They promoted strong reducing power, DPPH free radical scavenging activity and also inhibiton of lipid peroxidation *in vitro* (Joseph Asir et al., 2014). Ethanolic extract of *P. foetida* was found to have antiulcerogenic effect, which can be related to its antioxidant activities. The extract increased significantly the gastric pH of tested ethanol and aspirin-induced rats. Among other effects it reduced the ulcer index as well as lipid peroxidation (Sathish et al., 2011). Ethanol extract of *P. foetida* leaves was evaluated for analgesic and anti-inflammatory action. The extract performed strong anti-inflammatory action agains acute paw edena in histamine and carageenan-injured rats , it also showed analgesic effects in mice (Sasikala et al., 2011). In more recent study, *P. foetida* stem ethanol extract showed significant supressant effects agains paw edema and inhibited granuloma tissue formation in rats (Fernandes et al., 2013).

Methanol extract of *P. foetida* leaves exerted antiepileptic activity in mice. Higher doses significantly reduced the severity of seizures induced by electricshock and pentylenetetrazol (Pavan et al., 2009). *P. foetida* extract of leaves showed specifically antidepresant effects *in vivo*, when it reduced the imobility time of mice subectet to tail suspension and forced swimming test (Santosh et al., 2011). Wattanathorn et al. (2010) did a study on neuroprotective effect of *P. foetida* against brain damage and impairment in the cerebral ischemia, induced by the occlusion of middle cerebral artery in mice. The alcoholic extract significantly decreased the infarct volume in cortical and sub cortical structures. Moreover, it enhanced the neurological score and improved sensory response to stimuli.

As *P. foetida* is known in Sri Lanka as treatment of *diabetes mellitus*, Siriwardhene et al. (2013) conducted study proving its effectivity. *P. foetida* aqueous extract of leaves exhibited significant antihyperglycemic activity in rats using oral glucose tolerance test (Siriwardhene et al., 2013).

In many indigenous medicines, the plant is used against diarrhea. In a study published by Asadujjamana et al., (2014), ethanol extract of *P. foetida* showed anti-diarrheal effect in castor oil-induced diarrhoea.

Aqueous extract of *P. foetida* was examined for its impact on genital zone of rats. Results showed that the extract significantly increased weight of the uterus and ovary. Moreover, hormone analysis showed that the serum luteinizing hromone was significantly increased in immature ovariectomized rats and pituitary gonadotropins and prolactin in adult non ovariectomized rats (Gome et al., 2012).

P. foetida also possess some anticancer potential. Fruit decoction of *P. foetida* was evaluated for inhibiton of activity of two metallo-proteases involved in tumor invasion. The extract inhibited both enzymes (Puricelli et al., 2003).

Piper sarmentosum (syn. *P. lolot*), is one of approximately 700 piper species existing among both hemispheres. In asian tropics can be found approximately 300 species (Jarmillo and Callejas, 2004). Plants from the genus Piper are important for both, medical and culinary utizilations (Raman and Galal, 2012). Indigenous people around the world use piper species for their analgesic, anti-inflammatory and narcotic effects. Those plants have great pharmaceutical potential. (Jarmillo and Callejas, 2004; Dũnga et al., 1996) *P. sarmentosum* has special importance for household food supplies in some countries of Southeast Asia, such as Vietnam or Laos. It is widely used by folk medicine of rural people against various health problems (e.g. cough, cold, abdominal pain, edema, toothache, rheumatism) (Květová, 2013). Yellowdawn (2008) reccomended drink made from mashed *P. sarmentosum* with wine and water for treating malaria. The roots of the plant are chewed together with betel nut in Indonesia. Chewing it with ginger is considered to be treatment against pleurisy there. Juice from the roots is used against asthma and cough. On the other hand, in Thailand, they use the root to cure stomach problems and pain in muscles. Moreover, in some parts of Southeast Asia it is applied on toothache (Tuntiwachwuttikul, 2006). Leaves have been proved to possess medicinal properties such as analgesic and anti-inflammatory effects. Moreover it was found to be an anti-swelling agent. The leaves showed antimicrobial effect against *Bacilllus pyocyaneus*, *S. aureus* and *B. subtilis.* (Loi et al., 1995). Moreover, methanolic essence of *P. sarmentosum* exerted anti-platelet aggregation activity (Li et al., 2007). Zakaria et al. (2010) confirmed anti-inflammatory and anti-nociceptive effect of the plant *in vivo*. Chanwitheesuk et al., (2005) confirmend antioxidant effect of the plant and suggested that there is a

correlation between the contents of vitamin C, vitamin E, tanninns, xantophylls, carotenes and phenolic with the antioxidant index.

Essential oil and extracts from *P. sarmentosum* showed antimicrobial activity against *Streptococcus mutans*, Lactobacillus sp., *Aggregatibacted actinomycetemcomitans* and *C. albicans* (Taweechaisupapong et al., 2010). Antimicrobial activities were also reported against *Pseudomonas aeruginosa*, methicilin resistant *Staphylococcus aureus*, *Klebsiella pneumoniae* and *E. coli* (Zaidan et al., 2005). It also showed antifungal activity against Penicillium sp., *Aspergillus niger* and *A. oryzae*. (Wanchaitanawong et al., 2005) Moreover, extract from the whole plant showed antiplasmodial activity *in vitro* and *in vivo* (Rahman et al., 1999).

Among others various possible benefits for human health, *P. sarmentosum* extract showed anticacarcinogenic activities in HepG2 cells (Ariffin et al., 2009). On the other hand, essential oil from the plant showed toxicity against Brotispa longissima (Qin et al., 2010) but extract did not show any toxicity when tested for mice even in estimated lethal doses (Ridtitid et al., 2007).

Scoparia dulcis is a valuable pantropical medicinal plant originally distributed in Tropical America. It is herbaceous weed growing up to 1 metre. (Bhandari, 1990) In India, it is used as a remedy against *diabetes mellitus*, in Taiwan it is used as a hypertension cure and in Gambia, a lotion from the plant is a common treatment of fever. (Okhale et al., 2010). Some indigenous tribes of Nicaragua use the decoction or hot water infusion of the leaves against malaria, insect bites, heart problems, stomach, liver and menstrual disorders and as a blood cleansing tonic (Burkill, 2000). Beside of it, different medicinal systems in many parts of world use *S. dulcis* against diarrhea, ulcers, cough, tuberculosis, bronchitis, inflammation, cancer, wounds and skin rash. It is also considered an analgesic and antipyretic agent (Okhale et al., 2010).

S.dulcis was recorded as a traditional treatment of diabetes, it was found a reservoir of diverse type of phytochemicals that makes it a potent antidiabetic agent. Numerous studies *in vitro* and *in vivo* were conducted on the topic. In a study published by Lathra and Pari (2004), aministration of the plant aqueous extract significantly decreased the blood glucose and increased the plasma insulin level in streptozotocin diabetic rats. In another study, this extract induced stimulation of insulin secretion from isolated pancreatic islet cells (Latha et al.,

2004). Moreover, the extract protected against streptozotocin-mediated cytotoxicity and nitric oxide production in rat insulinoma cell line (Latha, 2004).

Treatment with the aqueous *S. dulcis* extracts also significantly improved specific insulin binding in diabetic rats. The number of insulin receptors and affinity binding was reduced to normal nondiabetic levels also (Pari et al., 2004).

Aqueous extract also significantly increased the activities of plasma insulin, catalase, superoxide dismutase, glutathione peroxidase, glutathione-S-transferase, and reduced glutathione. Moreover decreased thiobarbituric acid reactive substances and hydroperoxids formation in brain, that could have protective effect against lipid peroxidation induced membrane damage (Ahmed et al., 2001). Langeswaran et al. (2012) tested aqueous extract of *S. dulcis* for its antioxidant and hepatoprotective activity against N-nitrosodiethylamine induced liver cirrhosis in rats. The extract exhibited significant increase in levels of antioxidant enzymes and decrease in lipid peroxide and markers reflecting the liver damage. Anti-inflammatory properties of *S. dulcis* were tested among others in study published by Tsai et al. (2011). Ethanol extract reduced carageenan-induced paw edema in mice. The extract increased the activities of superoxide dismutase, glutathione peroxidase and glutathione reductase in the liver tissue and decreased the levels of malondialdehyde in the edema paw tissue. It can partly explain the anti-inflammatory effect of the plant. *S. dulcis* is also an effective anti-ulcer agent. Aqueous extract of leaves of *S. dulcis* was investigated for its anti-ulcer activity against pylorus ligation and ethanol induced ulcer in rats. It showed significant reduction in free acidity, gastric volume and ulcer index (Girish et al., 2011).

Various extracts of *S. dulcis* were tested for their neuroprotective effects. They exerted strong effect on brain neuronal cells and neurotransmitter enzyme as acetylcholinesterase. Additionaly, the extracts also significantly prevented rat erythrocytes haemolysis *in vitro* (Coulibaly et al., 2011). In a recent study published by Elayaraja et al. (2015), ethanolic extract of *S. dulcis* showed anti-anxiety effect in rats evaluated by various behavioral tests. Another recent research investigated the plant sedative and hypnotic properties. Ethanolic extract produced a significant dose-dependent inhibition of locomotor activity of mice and also decreased their induction time to sleep and prolonged the duration of sleeping. Moreover, ethanolic extract exerted significant analgesic activity in mice (Zulfiker et al., 2010).

Many traditional systems of medicine use it against diarrhoea, in a study published by Amitabha Dey et al. (2013), ethanolic extracts of *S. dulcia* were proved to have this effect. It significantly reduced frequency of stooling in castor oil-induced diarrhoea in rats.

The plant is known as antimicrobial agent, in a study of Zulfiker Abu Hasanat et al. (2010), extracts of *S. dulcis* showed moderate antibacterial activity against *S. aureus, Bacillus megaterium* and *Shigela boydii* and strong activity against *Salmonella paratyphi* and *Shigella dysenteriae*. It also exhibited moderate anti-fungal activity against *Saccharromyces cerevaceae*. Moreover, it exerted strong cytotoxicity in brine shrimp lethality bioassay. In another study showed various extract of *S. dulcis* significant antimicrobial action against bacteria *Bacillus cereus* and *Salmonella typhimurium* and fungi *Aspergillus niger* and *Penicillium roqueforti* (Coulibaly et al., 2012).

S. dulcis could have also a potential in treatment of Human Immunodeficiency Virus. The methanolic extract of *S. dulcis* leaves showed remarkable HIV type-1 reverse transcriptase inhibitory activity *in vitro* (Porika et al., 2009).

In a recent study, the extracts of *S. dulcis* exerted significant anti-larvicidal activity against dengue vector *Aedes aegypti* (Wankhar et al., 2015).

Wild edible plant, *Centella asiatica* is distributed in many tropical and subtropical regions. It is indigenous to the Southeast and East Asia including the part of islands , South Africa and Madagascar, Mexico, South East USA, Venezuela, Columbia and Eastern South America. It can be found even in high altitudes (Subban et al., 2008). In Indian literature it is reported to have effects on central nervous system such as nerve tonic, sedavite, rejuvenannt ant tranquilizing effects. It is also reported to increase intelligence and memory (Kapoor, 1990). It is also commonly used as a nutritious porridge known as *Kola kena* for pre-school children in Sri-Lanka. It is made of *C. asiatica*, boiled rice and coconut milk (Cox et al., 1993). *C. asiatica* was reported to be amongst the Lao´s most common wild edibles growing in paddy fields and to be found on markets (Kosaka et ak., 2013). *C. asiatica* is widely available on many markets in form of tea and soft drinks (Singh et al., 2010).

Because of its wide distribution, *C. asiatica* has its place in many cuisines of Asia, Africa and America. In Vietnam and Thailand, the leaves are used for preparing cold rolls or drinks (Das, 2011). The plant juice is also considered a nutraceutical drink (Bown, 1995). On the other hand, in Indonesia, the leaves are used for *Sambai oi peuga-ga*, an Aceh type of salad, while in Sri-Lanka, it is used for preparation of *Malluma,* which traditionally accompanies rice and curry. In Malay cuisine, the leaves of this plant are used for *Ulam*, a type of Malay salad . In Brazil, leaves of the plant are used for preparation of chutney (Das, 2011). Tribes in Western ghats in India use *C. asiatica* for dish called *Muthil*, which is the

plant prepared with crab or fish (Narayanan and Kumar, 2007). *C. asiatica* is also costituent of *Thandaayyee*, which is an Indian summer drink (Prakasha and Krishnappa, 2006).

The nutritional value of *C. asiatica* is promising as it is rich in carotenoids and vitamin C and vitamin B (Das, 2011). All components of the plant, especially roots, were found to be accumulating heavy metals. Iron accumulation was the highest followed by zinc and lead (Ong et al., 2011).

Passiflora foetida and her medicinal uses were discussed above but it is also of great importance as wild edible plant. Among the Passiflora genus, 60 species are edible (McGuire, 1999). Some species (e.g. *P. edulis*, *P. quadrangularis*, *P. ligularis*) are cultivated for the production of fruit and fruit juice. (Fouqué, 1972) Several species are mostly collected, as they are weeds, including *P. foetida*. Fruit of the plant is approximately two centimeters wide and contains mildly sweet and flavoured pulp. Young fruit is cyanogenic but it was also reported to be eaten by villagers in India (Singh et al., 2010). *P. foetida* was found to containt great ammount of proteins, it contains also larg ammounts of vitamin C, zinc and potassium (Hoe and Siong, 1999). It has also remarkable content of B-vitamins, particularly folates (Ogle et al., 2001). Beside of human nutrition it was reported to be an important part of duck feed in Vietnam (Ogle et al., 2003).

Plantago major belongs to the the family Plantaginaceae, which includes more than 200 species, lot of them with medicinal and edible use (Blacquiere and Koetsier, 1988). It is native in the Northern Europe and Central Asia but now it can be found almost all over the world, mainly in grasslands of temperate zones (Velasco-Lezama et al., 2006). It was spread by men from Europe throughout the world (Jonsson, 1983).

P. major is used as a medicinal and edible plant. Native Americans used powdered roots of *P. major* as protection against snake bite. In traditional Chinese medicine, *P. major* is used for treatment of viral related disease from colds and influenza to viral hepatitis (Chiang et al., 2002). It is a favourite vegetable in some Mediterranean cuisines, where it is usually consumed raw in sallads (Wright, 2001). The most usually eaten parts are leaves and seeds. The seeds are quite small with an ovate shape and a slightly bitter taste. Raw seeds can be used as laxative (Samuelsen, 2000). Glabrous leaves are collected young while they are still soft and fresh because older ones are too tough for consumation. Both, leaves and seeds were reported to contain proteins, fats and fibre (Kobeasy et al., 2011). Moreover, the leaves are rich in

carotenes. (Guerrero and Rodríguez, 1999) *P. major* is also rich in unsaturated fatty acids. Leaves and seeds are reported to contain high ammounts of linolenic, linoleic and palmitic acid and smaller ammounts of stearic and oleic acid. Seed can contain even around 25 % of linoleic acid (Liu et al., 2002). The plant was found to contain large ammount of amino acids, especially glutamic acid, aspartic acid, leucine and valine (Kobeasy et al., 2011). In addition, extracts of *P. major* were found to containt organic acid groups, flavonoids and terpenoids, mainly oleanolic and ursolic acid (Samuelsen, 2000).

Plantago consumation was repoted to have possible side effects in allergic people, like bloating or allergic reactions including nettle rashes, anaphylactic reactions, and sometimes even bronchial obstruction (Haddadian et al., 2014).

6. Conclusions

The summarization of literature data on wild medicinal and edible food plants used most commonly among various groups of Vietnamese people was gathered and the summarization of nine medicinal and three edible plants showed that the plants could solve or improve many health problems and enrich nutrition. Most of the plants have been tested for their biological effects but there is lack of studies confirming the health benecitial properties of *Schefflera heptaphylla*. Wild edbile plants were widely neglected by science, thus the relevant inormation on those species were fragmented and incomplete.

Some wild medicinal plants showed significant effect on metabolism, particularly neuroprotective (*Passiflora foetida, Renynoutria multiflora*) hepatoprotective (*R. multiflora, Curcuma zedoaria, Oroxylum indicum*) and antioxidation (*P. foetida, Plantago major, O. indicum*). Antioxidants can contribute to treatment of many civilizational diseases. *Cinnamomum cassia and O. indicum* were found to possess antiulcerogenic activities. Anti-inflammatory actions in various condtions were also recoded (*Morinda officinalis, P. foetida, Piper sarmentosum, Scoparia dulcis*). Moreover, *O. indicum* showed to be effective against arthritis. Some plants were found to be possibly effective against diabetes mellitus, which is common not only in Asia (*C. cassia, M. officinalis, O. indicum*). Nowadays is cancer treatment getting lot of attention, therefore the plants with potential to treat different forms of cancer can be of much importance. (*C. cassia, C. zedoaria, O. indicum, P. foetida*) Many plants possess antimicrobial activity (e.g. *P. foetida*). As a human immunodeficiency virus is a problem in the whole world, there could be demand for potential anti-HIV agents (*C. cassia, S. dulcis*).

The plants mentioned above can be recommended as sources for new herbal-based drugs, nutraceuticals or dietary supplements. However, more detailed pharmacological and nutritional studies are required for deeper understading of the species potential and effects. This study shows that wild edible plants are underdocumentated, thus should deserve higher attention by science, especially in the Northern Vietnam.

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