CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Institute of Tropics and Subtropics

Department of Crop Sciences and Agroforestry

Antioxidant activities of Peruvian medicinal plants

M.Sc. Thesis

LUCIE KUTÍLKOVÁ

2008

Abstract

An ethnobotanical inventory has been carried out in Peruvian Amazon in the Coronel Portillo Province of Ucayali Department. Use of 33 plant species, belonging to 20 families and 31 different genera, in traditional medicine is described in this work. Botanical and vernacular names, plant part used, popular medicinal use, forms of preparation and applications of the herbal remedies for each species are reported. The ethanol extracts of 14 of these species selected based on their ethnomedicinal use have been investigated for their *in vitro* antioxidant activity using 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging capacity assay. All the crude extracts were found to have scavenging effect on DPPH radical in the range of 5.34-257.65 μg/ml. Among them, *Calycophyllum spruceanum, Naucleopsis glabra, Triplaris peruviana* and *Phyllanthus amarus* possessed the strongest activity (EC_{50} = 5.34; 5.45; 6.79 and 6.91 μg/ml respectively), therefore could be considered as potential sources of new natural antioxidants.

Key words: Peru, ethnobotany, ethnopharmacology, medicinal plants, antioxidant activity, DPPH test

Abstrakt

V rámci této práce byla provedena etnobotanická inventarizace provincie Coronel Portillo ležící v regionu Ucayali v peruánské Amazonii. Popsáno bylo použití v tradiční medicíně pro 33 rostlinných druhů, náležících do 20 rostlinných čeledí a 31 rodů. Získaná data zahrnují, botanický název, místní název, používanou rostlinnou část, medicinální využití, způsob přípravy a použití léčiv. Antioxidační aktivita etanolových extraktů ze 14 druhů léčivých rostlin, vybraných na základě etnobotanických informací, byla testována *in vitro* za použití 1,1-difenyl-2-(2,4,6-trinitrofenyl)hydrazyl (DPPH) testu. Všechny zkoumané extrakty eliminovaly DPPH radikál v rozmezí 5,34-257,65 μg/ml. Nejvýznamnější antiradikálová aktivita byla stanovena pro následující druhy: *Calycophyllum spruceanum* (EC_{50}=5,34μg/ml), *Naucleopsis glabra* (EC_{50}=5,45 μg/ml), *Triplaris peruviana* (EC_{50}=6,79 μg/ml) and *Phyllanthus amarus* (EC_{50}=6,91 μg/ml), z čehož vyplývá, že by tyto druhy mohly být považovány za potenciální zdroje nových přírodních antioxidantů.

Klíčová slova: Peru, etnobotanika, etnofarmakologie, léčivé rostliny, antioxidační aktivita, DPPH test

Certification

I, Lucie Kutílková, declare that this thesis, submitted in partial fulfilment of the requirements for the degree of M.Sc., in the Institute of Tropics and Subtropics of the Czech University of Life Sciences Prague, is wholly my own work unless otherwise referenced or acknowledged.

Prague, April 20, 2008

Lucie Kutílková

Acknowledgment

The research was financially supported by Youth Activity Fund of Explorers Club (New York City, USA), Foundation "Nadání Josefa, Marie a Zdeňky Hlávkových" (Prague, Czech Republic) and Institute of Tropics and Subtropics. This research could not be realized without the support of Czech Development Cooperation Project with number 23/MZe/B/07-10.

I would like to sincerely thank to my supervisor doc. Ing. Ladislav Kokoška, Ph.D. from Department of Crop Science and Agroforestry (DCSA) of the Institute of Tropics and Subtropics (ITS) of the Czech University of Life Sciences Prague (CULS Prague), for his overall help, comments and suggestions and valuable information while leading my thesis.

Furthermore, I would like to thank to Ing. Zbyněk Polesný, Ph.D. (DCSA, ITS, CULS) for helpful advices and background provided during the time of data collection in Peru, to Mr. Rober Romero Robledo, Manuel Eli Odicio Guevara and other students of The National University of Ucayali in Pucallpa, Peru participating on the project for their valuable help with the transport to the field and assistance of the filed work. I am also grateful to Anders Henson (Ametra -Ucayali, Pucallpa, Peru) for the consultation of scientific information on selected species while filed work.

Special thanks go to Zoyla Mirella Clavo Perelta (Herbario Regional de Ucayali, Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, Pucallpa, Peru) for help with identification of plant species and to Mgr. Blanka Svobodová (DCSA, ITS, CULS) for helpful guidance while laboratory work.

Most importantly I wish to thank to all participating respondents for sharing their knowledge and wisdom on traditional medicinal use of plants with intention to help to realize this work.

Contents

Foreword

Nearly 80% of the world population use traditional medicine, mainly medicinal plants, to cure illnesses and ailments. In developing countries and rural societies, the use of medicinal plants is both a valuable resource and a necessity, and furthermore it provides a real alternative for primary health care systems (Macia et al., 2005). In recent years, plants have become an exceptionally viable source of biologically active natural products which may serve as commercially significant therapeutic agents (Desmarchelier and Schaus, 2000). Rediscovery of the connection between plants and health is responsible for launching a new generation of botanical therapeutics that include plant-derived pharmaceuticals, multicomponent botanical drugs, dietary supplements and functional foods. Many of these products will soon complement conventional pharmaceuticals in the treatment, prevention and diagnosis of diseases, while at the same time adding value to agriculture (Rios at al., 2005). Thanks to the indigenous inhabitants, who still largely depend on natural resources, the important ethnomedicinal knowledge survives. Nevertheless, it should be verified and preserved by modern scientific methods. The phytochemical research based on ethnopharmacological information is generally considered as an effective approach in discovery of new therapeutic agents from higher plants (Hammond et al., 1998). It has been estimated that over 250,000 flowering plants grace earth, of these about 40,000 can be found in the Amazon River Basin. In the case of Peruvian flora about 20,000 species or 8 % of the total number of plants that exist in the world can be found in the region. However, probably less than 1 % has been studied for their chemical composition and medicinal use (Desmarchelier and Schaus, 2000).

Thus, we assume that an ethnobotanical study of selected plant species used traditionally by local inhabitants of Coronel Portillo Province of Ucayali Department will lead to exploration of new data on species containing biologically active extracts. Since chemistry and pharmacology of certain species is still poorly known we decided to test 14 of these species, and evaluated them for potential antioxidant activity, in order to confirm their popular use and to compare their efficiency with standard plant sources of antioxidant agents.

1. Introduction

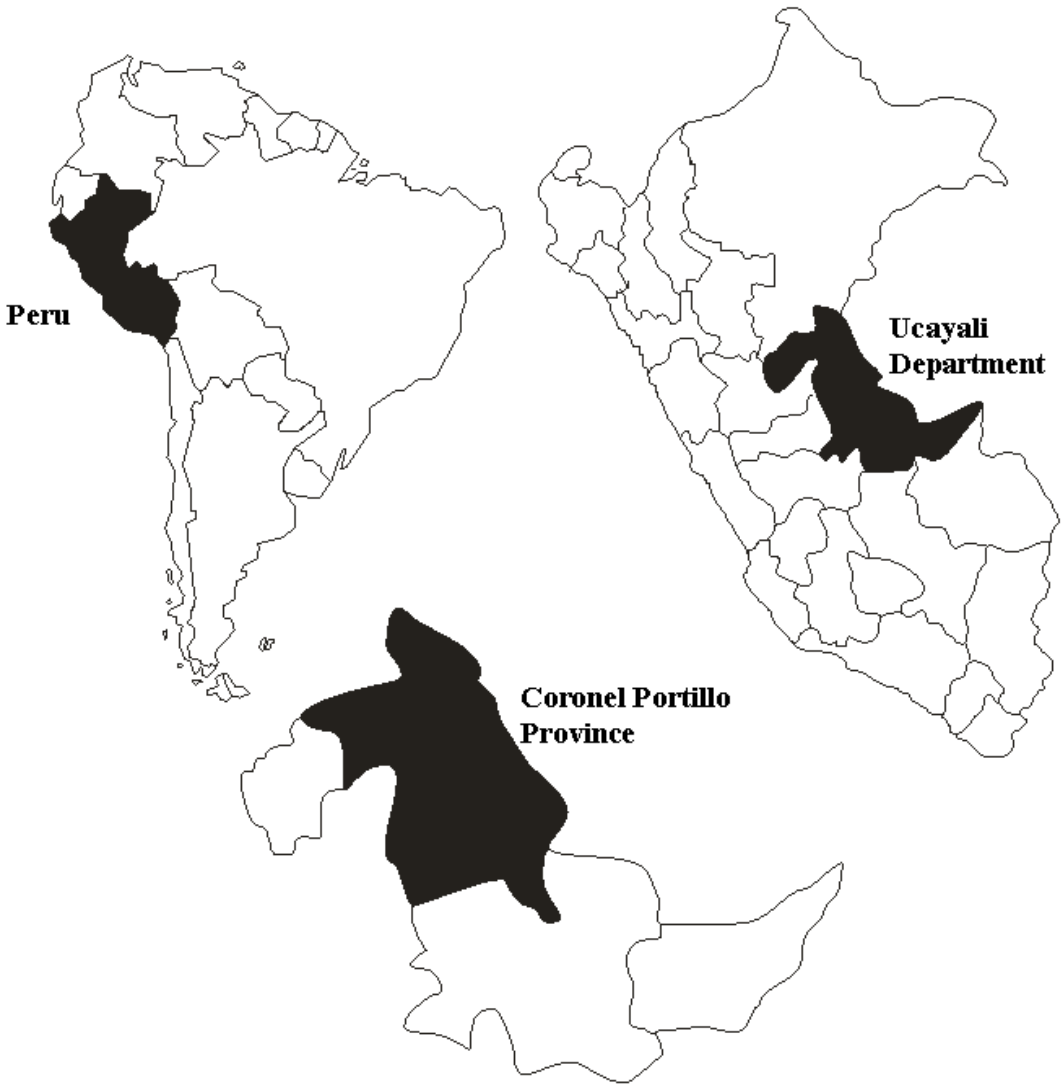
1.1. Study area

1.1.1. Location and geographical description

The Republic of Peru is situated in the eastern part of central South America. It is limited at the west by Pacific Ocean, at the north by the Republic of Ecuador and Colombia, at the east by Brazil and Bolivia and finally at the south by Chile. It lies between 68° 39′ and 81° 19′ western longitude and 00° 01′ and 18° 20′ southern latitude (Raul, 2000). Total area of the country is 1,285,220 sq km and it is divided into 25 regions: Amazonas, Ancash, Apurimac, Arequipa, Ayacucho, Cajamarca, Callao, Cusco, Huancavelica, Huanuco, Ica, Junin, La Libertad, Lambayeque, Lima, Lima, Loreto, Madre de Dios, Moquegua, Pasco, Piura, Puno, San Martin, Tacna, Tumbes, Ucayali (CIA, 2008).

The study was performed in communities of Amerindians of the tribe Shipibo-Konibo around Pucallpa city in the Amazon basin of Peru and in the city itself. Pucallpa is administrative centre of Coronel Portillo Province and the capital of Ucayali Department (Figure 1). The city, lying on the banks of the river Ucayali, is located 860 kilometres from Lima, with altitude of 154 meters above sea level, 8°23' of south latitude and 74°31' of west longitude. Ucayali Department borders Brazil to the east, along an east-west gradient leading to the foothills of the Andes. The area of Ucayali Department is 102,410 sq km (13% of Amazon basin) and is divided into 4 provinces: Coronel Portillo, Padre Abad, Atalaya and Purús (Pimental, 2004).

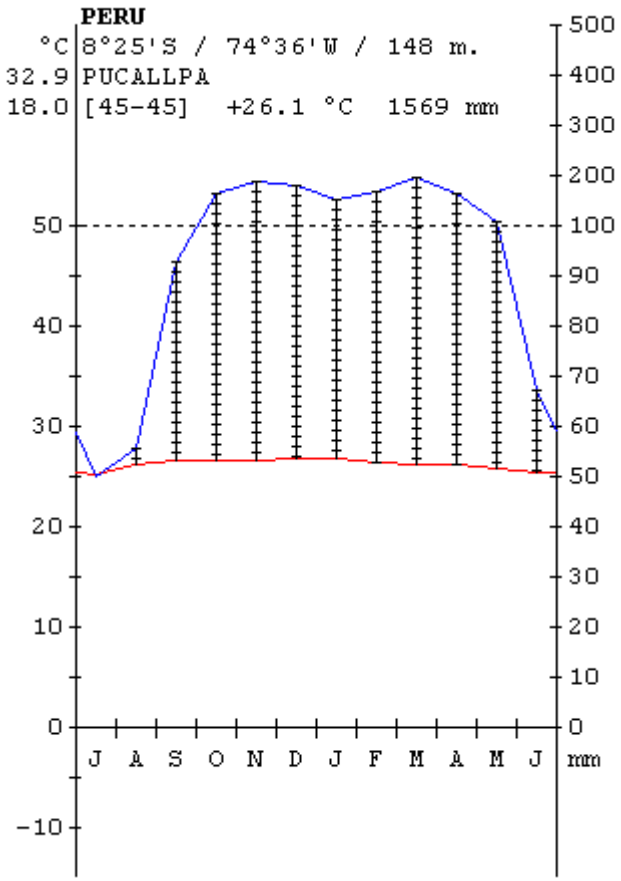
Figure 1: Location of the Coronel Portillo Province and Ucayali Department in Peru



1.1.2. Climate and soil conditions

Pucallpa is characterized by humid tropical forest cover and by hot and humid climate that varies only imperceptibly throughout the year. The rainfall ranges from 1,800 to 3,000 mm, raining season is from February to May and from September to December (Fujisaka et al., 2000). The mean annual temperature is 26.1°C (Figure 2) and means annual relative humidity reaching 80 % (Odar and Rodrígues, 2004). Soils include alluvial, riverine systems, with pH about 7.7 and 15 mg/g available P; and higher, well-drained forest areas of acidic (pH 4.4), low P (2 mg/g) soils (Fujisaka et al., 2000).

Figure 2: Climate diagram of Pucallpa, Peru (Source: Martinez, 1996)



1.1.3. Population

Traditional settlement in the area has been in scattered villages along the Ucayali River, a tributary to the Amazon. In the 1940s, a road connecting Lima to Pucallpa, the main city in Ucayali, was constructed, and this opened up the area to settlement from other regions and to exploitation of natural resources. Since 1972, the population has tripled from 130,000 to 370,000. Today more than 80% of the population in the Ucayali is concentrated in Pucallpa or along the road to Lima. There are four ecologically and demographically distinct subregions: the heavily populated Pucallpa subregion, including the road; the floodplain areas along the Ucayali, where the indigenous Shipibo–Konibo and mixed-race population is concentrated; the main extraction areas for timber resources in the upper regions of the Ucayali; and the isolated upland terraces in the Purus River Valley. These four subregions are highly integrated; many inhabitants migrate to different subregions at different times during the year to take advantage of income opportunities (Goy and Waltner-Toews, 2005). Coronel Portillo Province has 345,233 inhabitants

thereout 17,658 are native people living in 87 communities. The traditional agriculture is the primary livelihood of the village people, for food, fodder, fuels and medicaments (Pimental et al., 2004).

1.2. Peruvian folk medicine

In Peru, due to its complicated geography and economic factors related to cultural and logistical problems, traditional medicine continues to survive. Like in other developing countries, medicinal plants still represent the main therapeutic tool in folk healing (Rojas et al., 2003). The recognition and the use of medicinal plants is an untouchable heritage of most preliterate cultures. Over the centuries, every population has developed its knowledge in recognizing, harvesting and using plants to cure infirmities (de Feo, 1992). Folk medicine, one of Peru's oldest cultural traditions, is practiced by shamans or healers. The shamanic culture in the Andean area of Peru is very old. Its origins certainly predate the Columbian eras and, since then, have been enriched by continuous intercultural and interethnic relationships (Polia, 1988).

Several ethnic groups have lived in Peruvian Amazon for centuries, thus they developed a deep knowledge of the ecosystems which inhabit. The peoples have practised consistent application of different plant species for various ailments for millennia, and have transmitted this long term experience from one generation to the next (Desmarchelier and Schaus, 2000). Thanks to the indigenous inhabitants, who still largely depend on natural resources, the important ethnomedicinal knowledge survives. Nevertheless, it should be verified and preserved by modern scientific methods (Hammond et al., 1998).

1.3. Ethnobotanical studies

The ethnobotanical approach uses the medical knowledge of traditional societies to select plants for testing bioactivities. The success rates of this approach are substantially higher than those of random screening, with the additional advantage that, to some extent, the continued use of crude preparations are, in fact, comparable to small-scale clinical trials, raising the chances of obtaining something amenable to human use (Basso et al., 2005).

Previously a great number of studies concerning the use of medicinal plants in several parts of Peru have been carried out. Schultes and Raffaud (1990) in their book The Healing forest briefly described some medicinal and toxic plants of the Northwest Amazonia. Traditional use of some Andean medicinal plants was reported (Bastien and Stauffer, 1987; De-la-Cruz et al., 2007). Davidson (1983) briefly pointed the survival of

traditional medicine in a Peruvian *barriada*. Luna (1984) observed the healing practices of Peruvian shamans. Ethnomedicine of northern parts of Peru was described in several studies (Bussmann and Sharon, 2006; de Feo 1992; 2003). A summary report about project running in Peru in search for new biomedicines was published (Rodriguez and West, 1995). Ethnobotanical use of Peruvian medicinal plants of different ethnical groups was published by several authors (Jovel et al., 1996; Hammond et al., 1998; Desmarchelier 1996 a; Dunstan et al., 1997; Lewis at al., 1999).

2. Study background

2.1. Previous ethnobotanical inventories in studied region

Despite a rich tradition of folk medicinal usage of plants in Peruvian Amazon and certain ethnobotanical studies published (Desmarchelier at al., 1996 a; Desmarchelier and Schaus, 2000; Jovel et al., 1996; Kvist et al., 2006; Schultes and Raffauf, 1990), there is still lack of studies documenting ethnobotanical information of Coronel Portillo Province of Ucayali Region.

2.2. Selected Peruvian plants

Abuta grandifolia (Mart.) Sandwith

Family: *Menispermaceae*

Synonyms: *Cocculus grandifolius* Mart.

Description: Woody lianas or small bushes to 3 m tall, sarmentose or climber (Appendix 1). Trees are until 6 m tall. Leaves are alternate, coriaceous, glabrous. Inflorescence is axial (Appendix 2). The fruit is cylindrical, with 3 rather hard drupes, seed is hypocrateriform, and endosperm is rudimentary (Vasquez, 1998).

Amburana cearensis (Fr.Allem.) A.C.Sm

Family: *Leguminosae*

Synonyms: *Torresea cearensis* Allemão

Description: Emergent trees 20-35 m tall. The trunk has very characteristic reddish-papery, fragrant bark. Leaflets are rather many, membranaceous, and alternate. Flowers are white or yellowish in panicle inflorescence. Fruit is elongate pod with 1-2 seeds (Desmarchelier and Schaus, 2000).

Anacardium occidentale L.

Family: *Anacardiaceae*

Common name: Cashew

Description: Large, aromatic trees 5-15 m tall. Leaves are broad obovate with rounded apex and usually well differentiated petiole. Inflorescence is openly paniculate, with small yellow or pink flowers (Appendix 3). Fruit is nut with an enlarged, fleshly edible aril (Appendix 4) (Desmarchelier and Schaus, 2000).

Brunfelsia grandiflora D.Don

Family: *Solanaceae*

Synonyms: *Brunfelsia calycina* Benth.

Description: Small glabrous trees or shrubs to 5 m tall. The leaves are alternate, rather large, coriaceous, entire, elliptic with short petiole. Inflorescence is cyme (Appendix 5). Flowers are large light blue or pinkish purple. The fruit is berry (Appendix 6) (Brack, 1999).

Caesalpinia spinosa (Molina) Kuntze

Family: *Caesalpiniaceae*

Synonyms: *Poinciana spinosa* Molina, *Tara spinosa* Britton & Rose

Common name: Spiny holdback

Description: Shrubs or small trees to 5 m tall with reflexed prickles along its spreading spinose grey-barked densely leafy branches. Leaves are bipinnate, oblong-elliptic with glabrous leaflets. Flowers are reddish-yellow, in narrow racemes (Appendix 7). Frut is red pod 10 cm long with 4-7 seeds. Seeds are large, round and black at maturity (Duke, 1981).

Calycophyllum spruceanum (Benth.) K.Schum

Family: *Rubiaceae*

Synonyms: *Eukylista spruceana* Benth.

Description: Tall, erect and deciduous trees 15-27 m tall. The bark on the trunk is brown or greenish papery peeling (Appendix 8). Leaves are simple, oblong or obovate-oblong. Inflorescence is terminal with small white bisexual flowers. The fruit is oblong capsule with 3-5 compressed and pointed seeds (Appendix 9) (Brack, 1999).

Copaifera paupera (Herzog) Dwyer

Family: *Caesalpiniaceae*

Synonyms: *Copaiba paupera* Herzog

Common name: Copal

Description: Trees 20-30 m tall. Trunk is erect with rounded canopy. Bark is grey-greenish with small lenticels. Branches are glabrous. Leaves are alternate, compose, coriaceous. Inflorescence is terminal panicle with small, white, bisexual flowers. Fruits are small dehiscent pods with 1-4 seeds covered with orange aril (Appendix 10) (Brack, 1999).

Cordia alliodora Cham.

Family: *Boraginaceae*

Synonyms: *Cerdana alliodora* Ruiz and Pav., *Gerascanthus alliodorus* Kuhlm. and Mattos, *Lithocardium alliodorum* Kuntze

Common name: Clammy cherry

Description: Trees to 12 m tall (to 20 m where indigenous). Trunk bark is yellowish, garlic smelly (Brack, 1999). Leaves are oblong or lanceolate to elliptic, stellate-pilose or glabrate on both surfaces. Inflorescences are loosely branched racemes with small white flowers. Fruit is cylindric drupe, enveloped by the persistent corolla and calyx tube (Smith, 1991).

Croton lechleri Müll.Arg.

Family: *Euphorbiaceae*

Synonyms: *Oxydectes lechleri* Kuntze

Common name: Dragon's blood

Description: Large trees to 20 m tall. Bark is grey-white exudating dark red latex. Leaves are alternate, large, cordate with acuminate apex. Inflorescence is terminal raceme with numerous amber flowers. Frit is globose capsule, elastically dehiscent with 3 monocarps bivalves. Seeds are glabrate (Brack, 1999).

Dipteryx micrantha Harms

Family: *Leguminosae*

Synonyms: *Coumarouna micrantha* (Harms) Ducke

Description: Large tree of the primary forest, to 30 m tall, although smaller in secondary forests or when cultivated. The trunk is cylindrical, a light brownish-yellow color, with smooth bark and short buttresses. The leaves are compound, alternately pinnate, with elliptical-oblong leaflets which are frequently asymmetric. The panicle inflorescences are terminal, rusty colored, with hermaphrodite, zygomorphic, aromatic flowers. The fruit is an oblong-oval indehiscent drupe, yellow-green when mature. The seed is smooth, hard, dark purple-red in color, furnishing a clear yellow, aromatic (coumarin) oil (Prance and Silva, 1975).

Dracontium loretense K.Krause

Family: *Araceae*

Description: A rainforest understory plant that consists of a single, giant, deeply-divided leaf borne from an underground tuber on a long, thick stem which resembles the trunk of a sapling. When fertile, the flower stem emerges from near the base of the plant and rises up to 1–2 m in height (Appendix 11). At the end is a large, maroon spathe (a single, petal-like sheath) with bright red-orange, berry-like seeds crowded on a fleshy stalk inside (Zhu and Croat, 2004).

Equisetum giganteum L.

Family: *Equisetaceae*

Common name: Horsetail

Description: The stems (Appendix 12), growing 2-5 m tall, erect, 1-2 cm diameter, jointed, brittle and grooved, hollow except at the joints. There are no leaves, the joints terminating in toothed sheathes, the teeth corresponding with the ridges and representing leaves. Branches, if present, arise from the sheathbases and are solid. It bears a terminal cone-like catkin, consisting of numerous closely-packed peltae, upon the under margins of which are the sporanges (Vasquez, 1997).

Erythrina poeppigiana O.F.Cook

Family: *Leguminosae*

Synonyms: *Micropteryx poeppigiana* Walp.

Description: Trees to 35 m tall. Leaves are 3-foliolate covered with glands, the base is deltoid-ovate and the apex is acuminate or obtuse. Inflorescence is in terminal raceme with orange-yellow brilliant flowers. Fruit is legume (Vasquez, 1997).

Euterpe precatoria Mart.

Family: *Arecaceae*

Common name: Mountain cabbage

Description: Palms to 20 m tall. The trunk is erect long and eramous. Roots are adventitious orange-red. The canopy is conic created from 10-30 leaves. Leaves are 2-3.5 m long compose pinnate. Inflorescences are growing above leaves. The fruit is elliptic or oblong drupe, light brown on the surface containing 1-4 seeds (Reynel et al., 2003).

Hura crepitans L.

Family: *Euphorbiaceae*

Common name: Sandbox tree

Description: Large trees 20-40 m tall with spiny trunk and white, caustic latex. The bark is grey. Leaves are simple, alternate, ovate, serrate, long petiole with gland pair at apex above. Mail inflorescence is a thick, dense, almost conical, reddish spike. Female flower is solitary with superous ovary. Fruit is large globose capsule and explosively dehiscent into numerous segments (Desmarchelier and Schaus, 2000).

Jatropha gossypiifolia L.

Family: *Euphorbiaceae*

Description: Bushes to 1(3) m tall, reddish with glabrous branches. Leaves are 3(5) lobed with acuminate apex and cordate base. Leaf margin is entire or denticulate. Inflorescence is subterminal, pseudopaniculate cyme with red flowers. Fruit is capsule with 3 lobes (Vasquez, 1997).

Maytenus macrocarpa Briq.

Family: *Celastraceae*

Synonyms: *Celastrus macrocarpus* Ruiz and Pav.

Description: Trees to 30 m tall, trunk glabrous with subtabular (Appendix 13). Stalks are generally compressed. Leaves are alternate, elliptic or ovate-elliptic. The margin is entire. The underside is green. Flowers are in fascicles (a contracted cyme). Blossoms are globoses, with sepals slightly adpressed to cernuous. Fruit is ovate capsule, with rounded apex (Vasquez, 1997).

Naucleopsis glabra Spruce

Family: *Moraceae*

Synonyms: *Ogcodeia glabra* Mildbr.

Description: Dioecious trees to 20 m tall. It produces a yellowish and translucent sap. Branches are glabrous, yellowish to brown, or pilose, yellow to white. Leaves are alternate, cordate, lanceolate to oblong. The inflorescence is an emergency, axillary or under the leaves and unisexual. The fruit is an aggregate of achenes immersed in the succulent receptacle, subglobose, 2-5 cm of diameter and with spinose or pyramidal pseudo bracts (Vasquez, 1997).

Petiveria alliacea L.

Family: *Phytolaccaceae*

Description: Puberulent or glabrous herbs to 2m tall with garlic odour. Leaves are alternate, entire and elliptic to ovate (Appendix 14). Leaf apex is acuminate or mucronate. Inflorescence is spike with widely separated flowers, white or greenish. Fruit is small and narrow achene (Vasquez, 1997).

Phthirusa pyrifolia Eichl

Family: *Loranthaceae*

Synonyms: *Loranthus pyrifolius* Wight ex Wall., *Passovia pirifolia* Tiegh.

Description: Ephyfit erect plants (Clavo et al., 2003). Leaves are elliptic or ovate with obtuse apex and obtuse base. Inflorescence is axilar simple spike. Bisexual flowers are red coloured. Fruit is oblong berry (Vasquez, 1997).

Phyllanthus amarus Schumach. and Thonn.

Family: *Euphorbiaceae*

Synonyms: *Phyllanthus niruri* Wall.

Common names: Stone-breaker

Description: Small herbs to 60 cm tall (Appendix 15). Leaves are numerous, small, glabrous, oblong-elliptic. Leaf apex is obtuse and base is subcordate. Flowers are very small, in cymules hidden under the leaves. Fruit is small depressed-globose capsule. Seeds are 5-7-ribbed (Vasquez, 1997).

Physalis angulata L.

Family: *Solanaceae*

Synonyms: *Boberella angulata* (L.) E.H.L.Krause,

Description: Annual herbs to 1m tall. The stalk is greenish to brown, triangular at inferior and quadrangular at superior part. Leaves are simple, entire, alternate, ovate-elliptic, lanceolate, oblongate. Flowers are solitary, yellowish. Fruit is globose berry (Brack, 1999).

Piper aduncum Vell.

Family: *Piperaceae*

Description: Shrubs or small trees to 7 m tall. Leaves are alternate, distichous, elliptic, softly hairy beneath. Inflorescence is a leaf-opposed, curved spike white to pale yellow, turning green with maturity. Fruit is 1-seeded berry, compressed into greyish, wormlike spikes. Seeds are brown to black with a reticulate surface (Waterhouse and Mitchell, 1998).

Piper peltatum L.

Family: *Piperaceae*

Synonyms: *Pothomorphe pelt*ata (L.) Miq.

Description: Glabrous shrubs to 2 m tall. Leaves are orbicular, peltate with acuminate apex. Inflorescences are apical spikes, white or pale green gathered in groups of 4-10. Fruit is berry (Vasquez, 1997).

Pterocarpus rohrii Vahl

Family: *Leguminosae*

Synonyms: *Lingoum rohrii* Kuntze,

Description: Tree to 30 m tall. From the bark exudes red sap. Leaves are imparipinnates with alternate leaflets. The leaflets are oblong or oblong-elliptic. The inflorescence has few or lots of yellow or orange flowers (Appendix 18). The fruit is an indehiscent samara, rounded, with only one seed completely surrounded by a hard and slightly wavy wing (Vasquez, 1997).

Solanum mammosum L.

Family: *Solanaceae*

Commnon names: Nipple fruit, titty fruit, cow's udder

Description: Shrubs to 1.5 m tall. Stems are flexuous, white and brown simple pubescent with a few porrect-stellate hair clusters, with spines 11-14 mm long, flattened, straight or curved. Leaves are slightly cordate, white pilose on both surfaces, acicular spines on midrib and veins below. Inflorescence is congested umbelliform. Fruit is orange berry, mammose, the basal protuberances 3 or 5, orange, shiny (Appendix 20) (Welman et al., 2003).

Solanum sessiliflorum Dunal

Family: *Solanaceae*

Description: Shrubs up to 3 m tall, puberulous to tomentose with or without spines. Leaves are simple, ovate elliptic with acute apex and rotund-cordate base. Inflorescence is lateral cincinnus, white or pale green. Fruit is ovate-globose, from yellow to red berry (Vasquez, 1997).

Tabebuia chrysantha G.Nicholson

Family: *Bignoniaceae*

Synonyms: *Bignonia chrysantha* Jacq., *Tecoma chrysantha* DC.,

Description: Trees up to 30 m tall. Bark is pale grey and the wood is hard. Leaves are 5(7) foliolate, leaflets are elliptic to oblong-ovate. Inflorescence is panicle with yellow flowers (Appendix 19). Fruit is cylindrical capsule with winged seeds (Vasquez, 1997).

Terminalia catappa L.

Family: *Combretaceae*

Synonyms: *Buceras catappa* Hitchc.,

Common names: Indian almond, tropical almond

Description: Trees to 35 m tall. Leaves are large, ovoid, glossy dark green and leathery. They are dry-season deciduous, before falling, they turn pinkish-reddish or yellow-brown. Inflorescence is axillar or terminal spike with white to greenish flowers. Flowers are monoecious, with distinct male and female flowers on the same tree. The fruit is drupe green at first, then yellow and finally red when ripe, containing a single seed (Wagner and Herbst, 1999).

Triplaris peruviana C.A.Mey.

Family: *Polygonaceae*

Description: Dioecious trees up to 20 m tall with brown, pubescent, glabrate branches. Leaves are glabrous, oblong to lanceolate with acuminate apex. Inflorescence is raceme, brown, pubescent. Fruit is achene (Vasquez, 1997).

Uncaria guianensis J.F.Gmel

Family: *Rubiaceae*

Description: Large climbing, glabrous shrubs. Leaves are simple, elliptic of opposite disposition. Branches have strong, woody, down turned thorns (Appendix 24). Inflorescence is axilar, solitary with yellow flowers. Fruit is fuzzy and dry capsule (Vasquez, 1997).

Uncaria tomentosa D.C.

Family: *Rubiaceae*

Common name: Cat's claw

Description: Large climbing shrub to 20 m long (Appendix 21). Leaves are primary reddish, oblong to elliptic, simple, of opposite disposition, velvety, opaque, dark yellowish green (Appendix 22). Branches have strong, 2 cm long by 0.4 cm to 0.6 cm wide, woody

thorns that point down, not entwined (Appendix 23). Flowers are hermaphrodite, fragrant, solitary or grouped in clusters. Fruit is of brownish colour, fuzzy and dry capsule. The seeds have meaty albumen (Keplinger et al., 1999).

2.3. Natural antioxidants

There is increasing evidence that oxidative stress, in particular reactive oxygen species (ROS) and reactive nitrogen species (RNS), are involved in several inflammatory and degenerative diseases (MacDonald-Wicks et al., 2006). Oxidative damage caused by free radicals may be related to aging and diseases, such as atherosclerosis, diabetes, cancer and cirrhosis (Halliwell and Gutteridge, 1999). Therefore there is escalating interest in the efficacy of antioxidant activity of the many naturally occurring molecules in food and biological systems (MacDonald-Wicks et al., 2006).

ROS generation is essential to many important biological processes. For example, ROS are generated by all aerobic organisms as an unwanted by-product of normal oxygen metabolism. Thus, the body carries antioxidants, which inhibit the damaging reactions of ROS in tissues (Wood et al., 2006). An antioxidant is a substance that when present at low concentrations, compared to those of the oxidisable substrate, significantly delays, or inhibits, oxidation of that substrate (Halliwell, 1997). In foods, antioxidants have been defined as 'substances that in small quantities are able to prevent or greatly retard the oxidation of easily oxidisable materials such as fats' therefore in food science antioxidants are usually equated with chain-breaking inhibitors of lipid peroxidation (MacDonald-Wicks et al., 2006). Natural substances with antioxidant properties, contained in human diet, are antioxidant vitamins C, E and carotenoids. In recent years, the special importance is attributed to other natural substances especially polyphenols, which are contained in vegetable, fruit, tea, wine, aromatic and medicinal plants (Paulova et al., 2004).

2.4. Methods for assessing in vitro antioxidant activity

There are six major reactive oxygen species (ROS) and nitrogen species (RNS) that regularly interact and damage the major macromolecules in physiological and food-related systems: the superoxide anion ($O_2^{\bullet -}$), hydrogen peroxide (H_2O_2), the peroxyl radical ($ROO^{\bullet}$), the hydroxyl radical ($OH^{\bullet}$), singlet oxygen ($^1O_2$), and peroxynitrite ($ONOO^-$) (MacDonald-Wicks et al., 2006). Some of the mechanisms by which antioxidants act include: removing O_2 or decreasing local O_2 concentrations, removing catalytic metal ions, removing key ROS, e.g. $O_2^{\bullet -}$ and H_2O_2, scavenging initiating radicals, e.g. $^{\bullet}OH$, $RO^{\bullet}$, RO_2^-, breaking the chain of an initiated sequence, quenching or scavenging singlet oxygen,

enhancing endogenous antioxidant defences by up-regulating the expression of the genes encoding the antioxidant enzymes, repairing oxidative damage caused by radicals, increasing elimination of damaged molecules and not repairing excessively damaged molecules in order to minimise introduction of mutations (Gutteridge, 1994).

Many of the frequently cited assays of antioxidant capacity can be broadly categorised as either hydrogen transfer assays or single electron transfer reaction based assays. These assays measure the radical scavenging capacity or the reducing ability, respectively, not the preventative antioxidant capacity of the sample. Antioxidant activity refers to the rate constant of a reaction between a specific antioxidant and a specific oxidant. Antioxidant capacity is a measure of the amount (in moles) of a given free radical scavenged by a sample. Measurements of antioxidant capacity yield the amount of a heterogeneous mixture of antioxidants that react together to produce the total or net scavenging ability of the sample. The antioxidant capacity of each individual component is not measured. Following methods for assessing *in vitro* antioxidant capacity are described by MacDonald-Wicks (2006): Measuring of ROS and RSN scavenging (measuring of scavenging of superoxide, hydrogen peroxide, hydroxyl radical, singlet oxygen and peroxynitrite); methods that measure the uptake of oxygen; methods that measure the inhibition of induced lipid autoxidation; hydrogen atom transfer assays using molecural probes (the oxygen radical absorbance capacity-ORAC assay, total peroxyl radical-trapping antioxidant parameter-TRAP assay and Crocin-bleaching assay); electron transfer assays using molecural probes (total-phenol assay by using the Folin–Ciocalteu reagent-FCR, trolox equivalent antioxidant capacity-TEAC assay, ferric ion reducing antioxidant power-FRAP assay, total antioxidant potential assay using Cu(II) as an oxidant, 1,1-diphenyl-2-picrylhydrazyl-DPPH radical scavenging capacity assay).

For our study DPPH radical scavenging capacity assay was chosen, it is technically simple method widely used for determination of antioxidative activities of plant extracts (Miliauskas et al., 2004). Originally, it was believed that the DPPH assay was a hydrogen transfer reaction but recent work by Foti and co-workers (2004) suggests that it is, in fact, an electron transfer reaction. DPPH is a stable free radical that can accept an electron or hydrogen radical to become a stable diamagnetic molecule. Because of its odd electron, the methanolic solution shows a strong absorption band at 517 nm, which decreases in the presence of free radical scavengers (Goncalves at al., 2005). Originally, it was monitored by ESR spectroscopy and relied on the signal intensity of the DPPH radical being inversely related to the antioxidant concentration and the reaction time. More recently, this reaction

has been measured by the decolouration assay where the decrease in absorbance at 515–528 nm produced by the addition of the antioxidant to the DPPH radical in methanol or ethanol is measured (Sanchez-Mareno, 2002).

2.5. Biological activity of tested plant species

Abuta grandifolia

In vitro studies reported that this plant has insecticidal (Ciccia et al., 2000), antiplasmodial (Steele et al., 1999), antimalarial (Garavito et al., 2006), cytotoxic (Desmarchelier et al., 1996 b) and antimicrobial properties (Desmarchelier et al., 1996 b; Kloucek et al., 2007).

Caesalpinia spinosa

Tannins extracted from the pods of *C. spinosa* protect against skin tumor promotion induced by ultraviolet-B radiation in hairless mice (Gali-Muhtasib et al., 2000). The hexane extract of leaflets promoted partial inhibition of the mycelial growth of fungi *Fusarium solani* and *Phoma tarda* (Ferreira et al., 2005). Extracts from *C. spinosa* displayed antimalarial activity in *in vitro* studies (Bourdy et al., 2004). Plant extracts showed only weak *in vitro* antibacterial activity (Kloucek et al., 2005).

Calycophyllum spruceanum

Iridoids isolated from *C. spruceanum* showed *in vitro* activity against trypomastigote forms of *Trypanosoma cruzi* (Cardona Zuleta et al., 2003). Plant extracts were screened for *in vitro* inhibition of *Plasmodium* and *Leishmania* parasites (Kvist et al., 2006).

Cordia alliodora

High antifungal and larvicidal activities of root bark of *C. alliodora* were reported in i*n vitro* studies (Ioset et al., 2000; Rahalison et al., 1991; Vanisree et al., 2002). Six ant-repellent triterpenoids (Chen et al., 1983) and ant-repellent lupene glycosides (Schultes and Raffauf, 1990) have been identified in this plant. *C. alliodora* possesses significant antimicrobial effect (Kloucek et al., 2007).

There are no reports on antioxidant activity of *C. alliodora*, but another tropical species of genus *Cordia* showed antioxidant properties. The methanol and dichloromethane extracts of *C. gilletii* root bark demonstrated great antioxidant activity by scavenging the free radical DPPH with IC_{50} values of 3.2 and 8.1 μg/ml, respectively

(Okusa et al., 2007). *C. perrottettii* aqueous ethanol extracts showed inhibition of DPPH radical at 90 %, after 15 min of incubation at a test concentration of 50 μg/ml (Ruchi Marwah et al., 2007).

Dipteryx micrantha

Although, there are no published studies documenting biological activity of *D. micrantha*, Kloucek and co-workers (2007) described significant antimicrobial activity.

Equisetum giganteum

Diuretic (Caceres et al., 1987; Perez Gutierrez et al., 1985) and hypoglycemic (Cetto et al., 2000) activity was confirmed *in vivo*. Extracts examined for excitatory or inhibitory effects on the isolated rabbit aorta *in vitro* enhanced markedly its contractile responses (Matsunaga et al., 1997). Ethyl acetate fractions of *E. giganteum* possess nerve growth factor potentiating activity *in vitro* (Li et al., 1999). Antimycotic properties against *Fusarium oxisporum* a *Penicillium notatum* were described (Quiroga et al., 2001). No significant antibacterial activity was reported (Anesini et al., 2003; Portillo et al., 2001; Kloucek 2005).

Significant *in vitro* antioxidant activities were observed on other *Equisetum* species. The antioxidant activity of an aqueous extract (infusion) and respective ethyl acetate fraction of *E. telmateia* has been evaluated by DPPH, TEAC and TBARS assays. A high and significant antioxidant activity was detected in the ethyl acetate fraction (Correia et al., 2005). The scavenger activities of *E. arvense*, *E. ramosissimum* and *E. telmateia* aboveground parts phosphate buffer (pH 7) extracts were evaluated using three different methods: DPPH assay, ESR and NO radical inhibition assay. The *E. telmateia* extract demonstrated the most relevant scavenger and antioxidant properties (Stajner et al., 2006).

Maytenus macrocarpa

Ethanol extracts of the bark evidenced anti-inflammatory and analgesic activities in various studies with mice (Taylor et al., 2005). Strong antimicrobial activity was described (Kloucek et al., 2007). Its antitumoral properties were attributed to tingenone and pristimerin (Perez et al., 1999). β-dihydroagarofuran sesquiterpene polyol esters showed marginal antitumor activity and one also showed low MDR reversing activity on the parasite protozoan *Leishmania tropica* line (Chavez et al., 1999). Macrocarpins have been isolated from the roots of *M. macrocarpa* and have been found to be cytotoxic against four tumoral cell lines (Chavez et al., 2000). Friedelan triterpene, islolated compound from the

stem bark exudates of *M. macrocarpa*, showed weak activity against aldose reductase and did not display antitumor activity against P-388 lymphoid neoplasm, A-549 human lung carcinoma, HT-29 human colon carcinoma, or MEL-28 human melanoma cell lines (Chavez et al., 1998). Two new dammarane triterpenes have been isolated from the stem bark exudates of *M. macrocarpa* and tested for antitumoral activity (Torpocco et al., 2007).

Although *M. macrocarpa* have not been studied for its antioxidant properties yet, taxonomically closely related species had been tested for antioxidant activity. Vellosa with co-workers (2006) evaluated the crude ethanolic extract of *M. ilicifolia* using an assay based on the bleaching of the radical monocation 2,2′-azinobis (3-ethylbenzothiazoline-6-sulfonic acid) ($ABTS^{\bullet+}$) and by HOCl scavenger capacity. Trolox and uric acid were used as positive controls. The results indicated *M. ilicifolia* root bark as a great source of antioxidants based on its potential as scavenger of radicals.

Naucleopsis glabra

Ethanol extract of stem bark of *N. glabr*a exhibited strong antibacterial activity (Kloucek et al., 2007).

Phyllanthus amarus

In clinical research over the years, the plant has demonstrated liver protective, antilithic (expels stones), pain-relieving, hypotensive, antispasmodic, antiviral, antibacterial, anticarcinogenic, diuretic, antimutagenic, and hypoglycemic activities (Taylor, 2005).

According to extensive use of this plant in traditional medicines for indications often connected with oxidative stress, many *in vitro* and *in vivo* studies investigating its antioxidant potential have been carried out. Antioxidant activity of fresh and dried *P. amarus* plant materials were evaluated using the Folin-Ciocalteau method, DPPH free radical scavenging activity and FRAP assays (Lim and Murtijaya, 2007). Methanol extract was evaluated by various antioxidant assays, including total antioxidant, free radical scavenging, superoxide anion radical scavenging, hydrogen peroxide scavenging, nitric oxide scavenging, reducing power and metal ion chelating activities. The strong antioxidant activity was reported and compared to standard antioxidants such as butylated hydroxytoluene and ascorbic acid (Kumaran and Karunakaran, 2007). Methanol and aqueous extracts of leaves and fruits showed inhibition of membrane lipid peroxidation, scavenging of DPPH radical and inhibition of reactive oxygen species *in vitro* (Harish and

Shivanandappa, 2006). DPPH radical scavenging assay showed that the *P. niruri* protein isolate possessed radical scavenging activity (Sarkar and Sil, 2007). *P. amarus* antioxidant properties were comfirmed in different *in vivo* studies (Bhattacharjee and Sil 2007; Chatterjee et al., 2006; Harikumar and Kuttan, 2007; Harish and Shivanandappa, 2006; Kumar and Kuttan, 2004; Naaz et al, 2007; Pramyothin et al., 2007).

Piper aduncum

P. aduncum exhibited antiviral, cytotoxic (Lohezic et al., 2002), antibacterial (Kloucek et al., 2005), antigonorrheal (Caceres et al., 1995) and antifungal (Braga et al., 2007; Navickiene et al., 2006) activities. The methanol a dichloromethane extracts were active in the brine shrimp cytotoxicity bioassay (Desmarchelier et al., 1996 b). Torres-Santos and co-workers (1999 a; b) described antileishmanial effects in their studies. Antimicrobial, cytotoxic (Orjala et al., 1994) and molluscicidal (Orjala et al., 1993) properties were recorded for this plant. The ethanol extract of leaves performed mediate antimicrobial activity against oral pathogens (Lentz et al., 1998). Ethanolic extract of *P. aduncum* also showed inhibitory activity in agar-well diffusion tests against the AIDS-related pathogens (Okunade at al., 1997). Methanol extracts of this plant were studied for adulticidal activity against *Aedes aegypti* (Hidayatulfathi et al., 2004). Chromenes isolated from *P. aduncum* exhibit significant anti-trypanocidal activities (Batista et al., 2008).

Despite numerous studies documenting antioxidant properties of different *Piper* species (e.g. Agbor et al., 2007; Chatterjee et al., 2007; Choudhary et al., 2002; Karthikeyan and Rani, 2003; Rathee et al., 2006; Tsai et al., 2003; Vijayakumar et al., 2004; Yamaguchi et al., 2006) no reports on investigation of *P. aduncum* antioxidant activity have been found.

Pterocarpus rohrii

The ethanol extract prepared from stem bark of *P. rohrii* possesses significant antimicrobial effect (Kloucek et al., 2007).

Terminalia catappa

For popular use of this species worldwide, numerous studies were published, describing antimicrobial (Pawar and Pal, 2002), antibacterial (Kloucek et al., 2005), antifungal (Goun et al., 2003), hepatoprotective (Gao et al., 2004), antidiarrheal (Swamy et al., 2006), anti-inflammatory (Fan et al., 2004), antidiabetic (Nagappa et al., 2003), immunostimulating, hypocholesterolemic, diuretic, and antitumor activity (Duke, 1992).

The antioxidant and hepatoprotective actions of *T. catappa* were evaluated *in vitro* and *in vivo* using leaves extract and isolated antioxidants. A water extract of the leaves of *T. catappa* showed a strong radical scavenging action for DPPH and superoxide anion. Chebulagic acid and corilagin were isolated as the active components from *T. catappa*. Both antioxidants showed a strong scavenging action for O^{2-} and peroxyl radicals and also inhibited ROS production from leukocytes stimulated by phorbol-12-myristate acetate (Kinoshita et al., 2007). Aqueous extracts from leaves were evaluated for their antioxidant activity, scavenging and chelating abilities. Tests showed high antioxidant activities and moderate scavenging abilities on hydroxyl radicals at 1 mg/ml (Chyau et al., 2006). Solvent extracts were evaluated and the antioxidant activities were in the order methanol, ethyl acetate, dichloromethane, pentane extracts and all showed a parabolic-like curve with the maximum at 0.1–0.5 mg/ml of solvent extract. Reducing powers of three methanol extracts and their scavenging effects on DPPH radicals were excellent at 0.5 and 0.1 mg/ml, respectively (Chyau at al., 2002). With respect to the antioxidant activity by the 1,3-diethyl-2-thiobarbituric acid method, the supercritical carbon dioxide extracts from yellow fallen and red fallen leaves exhibited higher inhibition of peroxidation than those from green leaves (Mau et al., 2003). Supercritical $CO^{(2)}$ extracts of leaves and seeds of *T. catappa* were applied for antioxidative characterization by supplementation in an iron/ascorbate system with linoleic acid and in a pork fat storage system for inhibition of conjugated diene hydroperoxide (CDHP) formation or in a free radical scavenging system with DPPH, the extracts of leaves exhibited potent antioxidative and DPPH scavenging activities and increased with an increase of leaf maturity. However, the seed extracts only exhibited potent inhibition of CDHP formation and very low DPPH scavenging activity (Ko et al., 2002). Antioxidant and hepatoprotective effects were confirmed *in vivo* (Lin et al., 1997; 1998; 2001). *In vitro* and *in vivo* antimetastatic effects of *T. catappa* leaves on lung cancer cells were described (Chu et al., 2007).

Triplaris peruviana

There are no reports on biological effects of *T. peruviana* and no species of this genus have been tested for its antioxidant activity yet.

Uncaria tomentosa

Heitzman (2005) summarized research on ethnobotany, pharmacology and phytochemistry of *Uncaria* genus in his work, pharmacological studies are described

according to cytotoxicity, anti-inflammatory, antiviral, immunostimulation, antioxidant, CNS-related response, vascular, hypotensive, mutagenicity and antibacterial properties. Cytostatic and contraceptive activity has been described (Aquino et al., 1991). *U. tomentosa* extracts showed *in vitro* antimicrobial (Garcia et al., 2005) and antibacterial (Kloucek et al., 2005) activity. Protective antimutagenic effects have been determined *in vitro* against induced photomutagenesis (Rizzi et al., 1993). The antitumor activity was described (Sheng et al., 1998). Epicatechins and cinchonains are responsible for anti-inflammatory and antiviral properties (Aquino et al., 1989).

The antioxidant properties of aqueous and ethanolic extracts of the *U. tomentosa* bark were evaluated using following assays: trolox equivalent antioxidant capacity, peroxyl radical-trapping capacity, superoxide radical scavenging activity and quantitation of total tannins and total phenolic compounds. The obtained results indicate high antioxidant capacity. (Pilarski et al., 2006). Desmarchelier (1997) tested different extracts of bark and roots of *U. tomentosa* utilizing tert-butyl-hydroperoxide-initiated chemiluminescence, production of thiobarbituric acid reactive-substances in rat liver homogenates and oxidative DNA sugar damage induced by Fe(II) salts. Decoction presented a potent radical scavenger activity, as suggested by its high capacity to reduce the free radical DPPH, and by its reaction with superoxide anion, peroxyl and hydroxyl radicals as well as with the oxidant species, hydrogen peroxide and hypochlorous acid. It also protected membrane lipids against peroxidation induced by the iron/ascorbate system, as evaluated by the formation of thiobarbituric acid-reactive substances (Gonçalves et al., 2005). The potential of ascorbic acid and decoctions prepared from green tea (*Camellia sinensis* Kuntze; family: *Theaceae*) and cat's claw, to limit cell death in response to oxidants were evaluated *in vitro* (Miller et al., 2001).

3. Objectives

The aim of this field research has been to document traditional ethnobotanical knowledge related to the use of medicinal plants in Coronel Portillo Province of Ucayali Department, Peru. The main objective of this work is to select the most prospective plant species for further testing of antioxidant activity and their screening.

In addition, description of studied area, Peruvian folk medicine and summary of previous ethnobotanical inventories are included as background information for this work. Moreover, data on botany and already reported biological activities of selected plant species are provided.

4. Materials and methods

4.1. Ethnobotanical data collection

The data were collected through direct interviews, based on questionnaires which were structured according to the standard methodical ethnobotanical procedures proposed by Martin (Martin, 2004). The interviews were registered on field notebooks, immediately. 33 plant species which are the most frequently used in the studied region were selected according to available ethnobotanical literature (Arévalo, 1994; Clavo et al., 2003; Desmarchelier and Schaus, 2000; Pinedo et al., 1997). The criterion for plant species selection was based on ethnopharmacological information concerning potential future role in such indications, where the antioxidant activities should be of substantial benefit, i.e. treatment of atherosclerosis, cancer, respiratory diseases (Wood et al., 2006), inflammatory affections (MacDonald-Wicks et al., 2006), neurological defects, cardiovascular diseases (Paulová et al., 2006) and diabetes (Halliwell and Gutteridge, 1999). The collected information on each identified species contains botanical and vernacular names, plant part used, popular medicinal use, forms of preparation and applications of the herbal remedies. The survey was conducted during the period June-October 2007. The information was collected from 23 persons (12 women, 11 men) whose age ranged from 22 to 78 years. Most of the interviewees (16) were more than 40 years old, and belong mainly to families, which still have a strong connection with traditional agricultural activities. The respondents were belonging to two main ethnic groups, 10 were Amerindians of the tribe Shipibo-Konibo and 13 mestic people.

All plant material was collected by the author and subsequently authenticated in cooperation with M. Clavo. Photographs and voucher specimens of studied plants were prepared to document identity of plant material. Voucher specimens were deposited in the Regional Herbarium of the Ucayali, Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, Peru.

4.2. Antioxidative assay

4.2.1. Plant material

Tasted plant species were chosen based on ethnobotanical data gathered previously, the traditional ethnopharamcologial application which could signify antioxidant activity was followed. Another selective factor was availability of identified plant material. Plant

samples were collected directly in the field side or purchased from herbalists on local market.

4.2.2. Extract preparation

Dried material was finely ground to powder. The extracts were prepared by maceration of powdered plant material (15.00 g) in 450 ml of 80% ethanol, at room temperature for five days in a dark place. All extracts were subsequently filtered (paper filter 80 g/m^2) under pressure, with a Sartorius filtration device, and evaporated in vacuum rotary evaporator (Buchi, Switzerland) at 40ºC.

4.2.3. DPPH test

Antioxidative activity of all plant extracts was evaluated *in vitro* using 2,2-diphenyl-1-picrylhydrazil (DPPH) free radical scavenging activity assay described previously by Blois (1958) with slight modifications. In disposable microtiter plates (96 flat-bottomed wells), two-fold dilutions (eleven) of each extract were prepared in concentrations ranging from 512 to 0.5 µg/ml. The last row was used as a control therefore no extract was added. Subsequently, 25 µl of freshly prepared 1mM methanol solution of DPPH (Sigma-Aldrich, Prague, Czech Republic) was mixed with the extract in each well (creating a final volume of 200 µl) to start the radical-antioxidant reaction. The samples were kept in the dark for 30 min at room temperature and then the decrease in absorption was measured. Radical scavenging activity of plant extracts against stable DPPH radical was determined spectrophotometrically. The changes in colour (from deep violet to light yellow) were measured at 520 nm on Multiscan Ascent Microplate Photometer (Thermo Fisher Scientific, USA). For each sample, three individual experiments were carried out in triplicates. Ascorbic acid (Sigma-Aldrich, Prague, Czech Republic) and ethanol extract of *Rosmarinus officinalis* L., plant with well documented significant antioxidant activity (Almela et al., 2006), were used as positive standards in the same concentration range as plant extracts tested. Radical scavenging activity was expressed at EC_{50} values (concentration of the test sample required to induce 50% scavenging effect on DPPH radical).

5. Results

5.1. Ethnobotanical data

Traditional medicinal uses of 33 plant species belonging to 20 families are reported in Table 1, in which the plant species are listed according to alphabetical order. For each species, the following ethnobotanical and pharmacognostic elements are provided: botanical name, local names, parts used, preparations, ways of administration, ailments treated, total number of reports and relevant percentage of citations. The most represented families are *Euphorbiaceae* (4 species), *Leguminosae* (4), *Solanaceae* (4) and *Rubiaceae* (3). According to the number of citations (20 and more) reporting their use in folk medicine following species were identified, *Brunfelsia grandiflora, Calycophyllum spruceanum, Copaifera paupera, Croton lechleri, Dracontium loretense, Hura crepitans, Jatropha gossypiifolia, Maytenus macrocarpa, Naucleopsis glabra, Petiveria alliacea, Phthirusa pyrifolia, Phyllanthus amarus, Uncaria guianensis, Uncaria tomentosa,* to be most popularly used in Coronel Portillo Province of Ucayali Department.

The most frequent indications are colds, rheumatism, wounds, diarrhoea, pains of different origin, kidney disorders, gastritis, inflammations, fever, ulcers, vaginal infections, skin fungi etc. Standard ways of remedies preparation are decoction (plant material boiled in water), tincture (plant material soaked in alcohol), infusion (extract in hot water), macerate (extract in cold water) or the plants can be used fresh or in form of cataplasm.

Table 1: *Medicinal plants used in Coronel Portillo Province of Ucayali Department*

Botanical name	Family	Local names	Parts used	Uses/Ailments treated	Preparations (administration)	Citations	
						(*n*)	(%)
Abuta grandifolia (Mart.) Sandwith	*Menispermaceae*	Abuta (S), Nishipacha (Sh)	Bark	Diabetes	Decoction (I)	10	43,48
				Malaria, stomach ache, nutritional disorders, hernia	Decoction (I)	2	8,70
				Cancer, cleaning of blood, arthritis, premature infant	Decoction (I)	1	4,35
			Trunk	Cleaning of blood	Decoction (I)	2	8,70
				Vaginal problems	Decoction (E)	1	4,35
			Whole plant	Diabetes, purgative	Decoction (I)	1	4,35
Amburana cearensis (Fr.Allem.) A.C.Sm.	*Leguminosae*	Ishpingo colorado (S), quinshon (Sh)	Bark	Colds	Decoction (I)	4	17,39
				Diabetes, anaemia	Decoction (I)	2	8,70
				After operations, tiredness, cancer, stomach ache, vomiting, rheumatism, pain of ovaries, bronchitis, asthma, cough, fever, dysentery, diarrhoea, respiratory problems	Decoction (I)	1	4,35
			Resin	Wounds, bites of insect	Decoction (E)	1	4,35

Table 1 *(Continued)*

Anacardium occidentale L.	*Anacardiaceae*	Marañón (S), Casho (Sh)	Bark	Diarrhoea	Decoction (I)	10	43,48
				Dysentery, haemorrhage, diabetes	Decoction (I)	2	8,70
				Stomach sickness, abdominal pains	Decoction (I)	1	4,35
			Bark and leaves	Diarrhoea	Decoction (I)	1	4,35
			Aerial part	Diarrhoea, inner injuries	Decoction (I)	1	4,35
			Seeds	Skin infections, skin fungi	Backed (E)	1	4,35
Brunfelsia grandiflora D.Don	*Solanaceae*	Chiric-sanango (S), sanango (S)	Root	Rheumatism	Tincture (I)	7	30,43
				Arthritis	Tincture (I)	4	17,39
				Colds	Decoction (I)	4	17,39
				Force	Decoction (I)	3	13,04
				Pain of ovaries, sexual potency, colds, pain of bones	Tincture (I)	2	8,70
				Rheumatism, laziness, cancer of uterus	Decoction (I)	1	4,35
			Bark	Flu	Decoction (I), Tincture (I)	2	8,70
			Leaves	Colds	Decoction (I)	2	8,70
				Rheumatism, arthritis	Decoction (I)	1	4,35
Caesalpinia spinosa (Molina) Kuntze	*Caesalpiniaceae*	Tara (S)	Seeds	Vocal chords	Decoction (I)	6	26,09
			Fruits	Neurosis, kidney disorders	Decoction (I)	2	8,70
				Anaesthetic, infections, wounds	Tincture (I)	1	4,35
			Flower and leaves	Fever, vomiting	Infusion (I)	1	4,35

Table 1 *(Continued)*

Calycophyllum spruceanum (Benth.) K.Schum.	*Rubiaceae*	Capirona (S)	Bark	Wounds	Decoction (E)	9	39,13
				Burns	Decoction (E)	7	30,43
				Cancer	Decoction (I)	3	13,04
				Pellagra, diarrhoea	Decoction (I), bath	3	13,04
				Cicatrising	Decoction (E)	3	13,04
				Acne	Decoction (E)	3	13,04
				Haemorrhage, ulcers, inner injuries	Decoction (I)	2	8,70
				Cough, asthma, vaginal haemorrhage, abdominal problems	Decoction (I)	1	4,35
				Scars, vaginal infections, haemorrhoids	Decoction (E)	1	4,35
Copaifera paupera (Herzog) Dwyer	*Caesalpiniaceae*	Copaiba (S)	Oleoresin	Wounds	Fresh (E)	15	65,22
				Ulcers	Fresh (I)	11	47,83
				Gastritis	Fresh (I)	9	39,13
				Cancer	Fresh (I)	4	17,39
				Gonorrhoea, haemorrhage, diarrhoea, inner injuries	Fresh (I), macerate (I)	2	8,70
				Burns	Fresh (E)	2	8,70
				Blood in urine, rheumatism, stomach ache, cists, laxative, syphilis, sinusitis, prostate, abdominal problems	Fresh (I), macerate (I)	1	4,35
				Cicatrising, vaginal infections	Fresh (E)	1	4,35
			Bark	Wounds, inner injuries, haemorrhage, blood in urine	Decoction (I)	1	4,35

Table 1 *(Continued)*

Cordia alliodora Cham.	*Boraginaceae*	Ajos-quiro (S)	Bark	Pain of bones	Tincture (I)	3	13,04
				Rheumatism, colds	Tincture (I)	2	8,70
				Bronchitis, prostate	Tincture (I)	1	4,35
				Rheumatism	Cataplasm	1	4,35
				Inflammations, arthritis	Decoction (I)	1	4,35
			Bark and leaves	Colds	Bath	3	13,04
				Rheumatism	Bath	2	8,70
			Roots	Arthritis, rheumatism	Cataplasm	2	8,70
Croton lechleri Müll.Arg.	*Euphorbiaceae*	Sangre de grado (S), himimosho (Sh)	Resin	Wounds	Fresh (E)	14	60,87
				Ulcers	Fresh (I)	11	47,83
				Gastritis, cancer	Fresh (I)	5	21,74
				Inner injuries, haemorrhage	Fresh (I), macerate (I)	4	17,39
				Vaginal infections	Fresh (E)	4	17,39
				AIDS, after operations, stomach ulcers	Fresh (I), macerate (I)	2	8,70
				Gonorrhoea, diarrhoea, cancer of uterus, pancreas, tuberculosis, abdominal problems, cold, flu, bronchitis	Fresh (I), macerate (I)	1	4,35
Dipteryx micrantha Harms	*Leguminosae*	Shihua-huaco (S)	Bark	Cold,	Decoction (I), Tincture (I)	5	21,74
				Rheumatism, arthritis, sexual potency	Tincture (I)	3	13,04
				Fragility	Decoction (I)	2	8,70
				All illnesses, force, prostate	Decoction (I)	1	4,35
				Conjunctivitis	Decoction (E)	1	4,35

Table 1 *(Continued)*

Dracontium loretense K.Krause	*Araceae*	Jergón-sacha (S), rununguro (Sh), shengo (Sh)	Tuber	Abdominal pains	Decoction (I)	7	30,43
				Rheumatism, bites of snake	Cataplasm	4	17,39
				Gastritis	Decoction (I)	2	8,70
				Wounds, nicks, pains, inflammations	Cataplasm	1	4,35
				Injuries, haemorrhage, kidney disorders, tumours, rheumatism, hernia	Decoction (I)	1	4,35
				Prostate, muscle tension	Macerate (I)	1	4,35
				Depressions, sexual potency	Tincture (I)	1	4,35
Equisetum giganteum L.	*Equisetaceae*	Cola de caballo (S)	Entire plant	Kidney disorders	Decoction (I)	15	65,22
				Prostate	Decoction (I)	5	21,74
				Vesicles	Decoction (I)	4	17,39
				Liver disorders, diuretic, urinal infections, kidney stones	Decoction (I)	1	4,35
Erythrina poeppigiana O.F.Cook	*Leguminosae*	Amasisa (S), casho (Sh)	Bark and leaves	Inflammations	Decoction (I)	4	17,39
				Fever	Decoction (I)	3	13,04
				Wounds	Decoction (E)	2	13,33
				High blood pressure, tumours, diarrhoea, rheumatism,	Decoction (I)	1	4,35
			Leaves	Fever, body cleaning, headache	Bath	2	8,70
				Burns, vaginal problems	Bath	1	4,35
			Bark	Malaria, abdominal parasites	Tincture (I)	1	4,35

Table 1 *(Continued)*

Euterpe precatoria Mart.	*Arecaceae*	Huasaí (S)	Roots	Kidney disorders	Decoction (I)	18	78,26
				Prostate, liver problems	Decoction (I)	3	13,04
				Haemorrhage	Decoction (I)	2	8,70
				Hernia, stomach sickness, fever, urinal infections, malaria, diuretic, hepatitis, kidney stones, diabetes	Decoction (I)	1	4,35
			Seeds	Diarrhoea	Decoction (I)	1	4,35
Hura crepitans L.	*Euphorbiaceae*	Catahua (S), ana (Sh)	Latex	Bites of spiders, pains	Fresh (E)	2	8,70
				Intestinal parasites	Tincture (I)	3	13,04
				Tumours	Tincture (I)	2	8,70
				Skin fungi, leprosies, pain of bones	Tincture (E), fresh (E)	1	4,35
				Colds, lack of appetite, tremble, cancer, vomitiv	Tincture (I)	1	4,35
				Laxante	Decoction (I)	1	4,35
			Leaves	Colds, parasites, inner injuries, rheumatism, AIDS, all illnesses	Infusion (I)	1	4,35
			Bark	Bites of snake, wounds	Tincture (E)	2	8,70
Jatropha gossypiifolia L.	*Euphorbiaceae*	Piñón Colorado (S)	Sap	Wounds	Fresh (E)	6	26,09
				Vaginal infections	Macerate (E)	3	13,04
			Leaves	Headache	Bath	5	21,74
				Purgative, laxative	Macerate (I)	3	13,04
				Cleaning of the body, fever, pain of bones	Bath	3	13,04
				Inflammations of digestive system, intestinal problems,	Macerate (I)	1	4,35
			Seeds	Vaginal problems	Decoction (E)	1	4,35

Table 1 *(Continued)*

Maytenus macrocarpa Briq.	*Celastraceae*	Chuchu-huasi (S)	Bark	Colds	Tincture (I), Decoction (I)	16	69,57
				Diarrhoea	Decoction (I)	4	17,34
				Arthritis, rheumatism	Tincture (I)	3	13,04
				Anaemia	Tincture (I)	2	8,70
				Wounds, bites of insect	Decoction (E)	2	8,70
				All illnesses, impotency, menstrual pains, tremble, ulcers, asthma, bronchitis, colic	Tincture (I)	1	4,35
				Blood cleaning, immunity, pains, stomach ache, ulcers	Decoction (I)	1	4,35
Naucleopsis glabra Spruce	*Moraceae*	Tamamuri (S), shana (Sh)	Bark	Arthritis	Tincture (I)	8	34,78
				Rheumatism	Tincture (I)	5	21,74
				Bones pain, colds	Decoction (I)	3	13,04
				Menstrual problems, diarrhoea	Tincture (I)	2	8,70
				Haemorrhage, cough, anaemia, dysentery, colic, abdominal pains, prostate	Tincture (I)	1	4,35
				Injuries, kidney disorders, infections, cancer	Decoction (I)	1	4,35
Petiveria alliacea L.	*Phytolaccaceae*	Mucura (S), boanis (Sh)	Aerial part	Bad mood	Bath	8	34,78
				Prevention of flu	Bath	5	21,74
				Headache, chill	Bath	2	8,70
				Fever, rheumatism, arthritis, bones pain, purification	Bath	1	4,35

Table 1 *(Continued)*

Phthirusa pyrifolia Eichl.	*Loranthaceae*	Suelda con suelda (S)	Entire plant	Fracture	Cataplasm	18	78,26
				Muscle injuries	Cataplasm	8	34,78
				Hernia, prostate, kidney disorders,	Decoction (I)	1	4,35
Phyllanthus amarus Schumach. and Thonn.	*Euphorbiaceae*	Chanca-piedra (S)	Entire plant	Kidney disorders	Decoction (I)	16	69,57
				Gall bladder problems	Infusion (I)	4	17,39
				Ulcers	Decoction (I)	3	13,04
				Liver inflammations, stomach ache, diuretic, pancreas	Decoction (I)	2	8,70
				Pains, heart problems, syphilis, colic, kidney stones, rheumatism, sexual potency, cholesterol, abdominal problems, vaginal problems	Decoction (I)	1	4,35
Physalis angulata L.	*Solanaceae*	Bolsa-mullaca (S), shimon (Sh)	Leaves	Skin fungi, wounds	Cataplasm, fresh juice (E)	3	13,04
				Gall bladder problems	Decoction (I)	3	13,04
				Blood cleaning, gastritis	Decoction (I)	2	8,70
				Allergy, bronchitis, pellagra, diabetes	Decoction (I), infusion (I)	1	4,35
				Bites of insect, scabies	Cataplasm	1	4,35
Piper aduncum Vell.	*Piperaceae*	Matico (S), yaushijotonte (Sh)	Leaves	Kidney disorders	Decoction (I)	5	21,74
				Vaginal infections	Decoction (E)	4	17,39
				Inflammations, stomach ache	Decoction (I)	3	13,04
				After operations, pains, prostate, colds, bronchitis	Decoction (I), Infusion (I)	2	8,70
				Wounds, blisters	Decoction (E)	1	4,35
				Menstrual pains, gastritis	Decoction (I)	1	4,35

Table 1 *(Continued)*

Piper peltatum L.	*Piperaceae*	Santa maria (S)	Sap	Conjunctivitis	Macerate (E)	6	26,09
				Fever	Macerate (I)	2	8,70
			Leaves	Pulsarios	Decoction (I)	4	17,39
				Inflammations, rheumatism	Infusion (I)	2	8,70
				Abdominal pains, nervous system, urinal problems,	Infusion (I)	1	4,35
Pterocarpus rohrii Vahl	*Leguminosae*	Yahaur-caspi (S)	Bark	Rheumatism	Decoction (I)	3	13,04
				Colds	Tincture (I)	2	8,70
				All illnesses, arthritis, anaemia, gastritis, osteoporosis, stomach sickness	Decoction (I)	1	4,35
				Chill	Cataplasm	1	4,35
Solanum mammosum L.	*Solanaceae*	Chuco de vaca (S), tinctona (S),topopo (Sh)	Fruit	Skin fungi	Cataplasm	14	60,87
				Sterility	Decoction (I)	2	8,70
				Skin infections	Cataplasm	2	8,70
				Bites of insect, wounds	Cataplasm	1	4,35
Solanum sessiliflorum Dunal	*Solanaceae*	Cocona (S), popo (Sh)	Fruit	Burns, wounds	Fresh juice (E)	4	17,39
				Diabetes	Tincture (I), decoction (I)	3	13,04
				Diarrhoea, blood pressure, nervous system	Tincture (I), decoction (I)	1	4,35
				Bites of snake, skin infections	Cataplasm	1	4,35
Tabebuia chrysantha G.Nicholson	*Bignoniaceae*	Tahaurí (S)	Bark	Diabetes	Decoction (I)	3	13,04
				Arthritis, impotency, colds	Tincture (I), decoction (I)	2	8,70
				Aphrodisiac, rheumatism, tuberculosis	Tincture (I), decoction (I)	1	4,35

Table 1 *(Continued)*

Terminalia catappa L.	*Combretaceae*	Almendra (S), Anacota (Sh)	Leaves	Diabetes, women sterility	Infusion (I)	2	8,70
				Blood pressure, blood cleaning, cholesterol, liver problems, gall bladder problems	Infusion (I)	1	4,35
			Bark	Kidney disorders, inner injuries	Decoction (I)	1	4,35
Triplaris peruviana C.A.Mey.	*Polygonaceae*	Tangarana (S), tejani (Sh)	Bark	Haemorrhage, blood cleaning, rheumatism	Decoction (I)	2	8,70
				Tiredness, diarrhoea, AIDS, stomach infections, cists, colds	Decoction (I)	1	4,35
				Rabidness, choleric	Tincture (I)	1	4,35
Uncaria guianensis J.F.Gmel. and *Uncaria tomentosa* D.C.	*Rubiaceae*	Uña de gato (S)	Bark	Kidney disorders	Decoction (I)	12	52,17
				Cancer	Decoction (I)	9	39,13
				Inflammations,	Decoction (I)	4	17,39
				Rheumatism, ulcers, vesicular, prostate, inner injuries	Decoction (I)	3	13,04
				Stomach ache, wounds, blood cleaning, gastritis, liver disorders, infections	Decoction (I)	2	8,70
				AIDS, arthritis, impotency, low blood pressure, urinal infections, intestinal parasites, anaemia, diabetes	Decoction (I)	1	4,35

Local names: (S) spanish; (Sh) shipibo-konibo. Way of administration: (E) external use; (I) internal use.

5.2. Antioxidative assay

Fiftheen ethanol extracts from 14 Peruvian medicinal plants were tested for antioxidant activity using DPPH radical scavenging capacity assay. The summary of the investigated species and the obtained EC_{50} values are given in Table 2. All the crude extracts were found to have scavenging effect on DPPH radical in the range of 5.34-257.65 μg/ml. Ascorbic acid and ethanol extract of *Rosmarinus officinalis* with EC_{50} values of 4.64 ug/ml and 7.84 ug/ml were used as positive standards. *Calycophyllum spruceanum, Naucleopsis glabra, Triplaris peruviana* and *Phyllanthus amarus* showed stronger scavenging effect (EC_{50} ranging from 5.34 to 6.91 ug/ml) than *R. officinalis* used as positive standard. The interesting activity was also observed for *Uncaria tomentosa, Terminalia catappa* and *Pterocarpus rohrii* with EC_{50} values ranging from 7.90 to 11.87 ug/ml. The extract prepared from root bark of *Maytenus macrocarpa* exihibited significant scavenging effect (EC_{50} = 7.94 ug/ml) comparable to *R. officinalis*, interestingly the stem bark extract of *M. macrocarpa* was markedly less effective (EC_{50} = 20.25 ug/ml). The lowest activity was performed by *Caesalpinia spinosa* (EC_{50} = 257.65 ug/ml) and *Dipteryx micrantha* (EC_{50} = 153.85 ug/ml).

Table 2: *Antioxidant activity (DPPH test) of tested medicinal plants*

Botanical name	Part tested	EC_{50} ug/ml
Abuta grandifolia	Stem bark	28.09
Caesalpinia spinosa	Pod	257.65
Calycophyllum spruceanum	Stem bark	5.34
Cordia alliodora	Stem bark	52.62
Dipteryx micrantha	Stem bark	153.85
Equisetum giganteum	Aerial part	78.00
Maytenus macrocarpa	Root bark	7.94
	Stem bark	20.25
Naucleopsis glabra	Stem bark	5.45
Phyllanthus amarus	Aerial part	6.91
Piper aduncum	Aerial part	38.14
Pterocarpus rohrii	Stem bark	11.87
Terminalia catappa	Leaves	11.36
Triplaris peruviana	Stem bark	6.79
Uncaria tomentosa	Stem bark	7.90
Ascorbic acid		4.64
Rosmarinus officinalis	Leaves	7.84

6. Discussion

Results of antioxidant screening were synthetically compared with data present in available studies investigating antioxidant activity of tested species. However, for ten (71 %) from fourteen plants tested, no scientific information concerning the antioxidant properties has been reported. The results of the antioxidant screening indicate that bioactivity could be detected for all plants tested. This reinforces the concept that the investigation of ethnobotanically used plants will reveal a substantial number of positive responses to *in vitro* screens.

Calycophyllum spruceanum stem bark extract showed the strongest scavenging effect on DPPH radical, what correlates with collected ethnobotanical information on its popular use for treatments of wounds, burns and cancer. There are no previous reports on antioxidant activity of this species.

Although the root bark extract of *Maytenus macrocarpa* showed considerable scavenging effect in this study, the extract of stem bark was less active than standards, which suggests the higher content of compounds responsible for antioxidant activity in underground plant parts. The antioxidant activity of *M. macrocarpa* has not previously been described. However, the study of taxonomically closely related species showed powerful antioxidant potential. Crude *M. ilicifolia* roots ethanolic extract showed marked action over HOCl (EC_{50} 1.9 μg/ml) and ABTS radical (EC_{50} 2.0 μg/ml). The extract was better HOCl scavenger than Trolox (EC_{50} 3.1 μg/ml), but worse than uric acid (EC_{50} 0.32 μg/ml). In relation to ABTS radical scavenger effect, the extract was less efficient than standards (Vellosa et al., 2006).

No studies investigating antioxidant properties of *Naucleopsis glabra* were found to compare our results with. According to results presented in this study and the fact that oxidative stress is involved in many inflammatory diseases, such as rheumatoid arthritis, multiple sclerosis, asthma, inflammatory bowel disease and atherosclerosis (Akesson et al., 2003), could be supposed that wide traditional use of *N. glabra* for treatment of arthritis and rheumatism has relation to its strong antioxidant effect.

Strong antioxidant properties of *Phyllanthus amarus* were confirmed in different *in vitro* studies using various antioxidant assays (Harish and Shivanandappa, 2006; Kumaran and Karunakaran, 2007; Lim and Murtijaya, 2007; Sarkar and Sil, 2007). This data are in line with results presented in this study, where the *P. amarus* showed stronger antioxidant activity than *R. officinalis* used as standard sample. Harish and Shivanandappa (2006)

recorded DPPH radical scavenging effect (EC_{50} 9.1 µg/ml) of methanolic extract prepared from leaves collected in India comparable to our results. Almost 70 % of respondents indicated main use of *P. amarus* for treatment of kidney disorders. This indication was experimentally confirmed *in vitro* (Barros et al., 2003; Calixto et al 1984; Campos and Schor, 1999) and the efficacy of *P. amarus* after extracorporeal shock wave lithotripsy for renal stones was studied in clinical trail (Micali et al., 2006).

According to our best knowledge this is the first report of antioxidant activity for *Pterocarpus rohrii*. Though, the significant scavenging effect on DPPH radical of plant extract observed in this study, may well explain its use in folk medicine for treatment of rheumatism and arthritis.

Scavenging effects of three methanolic extracts prepared from green, yellow fallen and red fallen leaves of *Terminalia catappa* on DPPH radical were active at concentrations as low as 0.1 mg/ml. At 0.1 mg/ml, the scavenging effects of the three methanolic extracts were 92.5–95.7% and comparable to those of vitamins C and E and butylatedhydroxyanisole (95.2–96.7%) used as controls (Chyau at al., 2002). Ko (1998) found that at 5 mg/ml, water extracts from green, yellow fallen and red fallen leaves of *T. catappa* scavenged DPPH radical by 52.1, 41.4 and 41.1%, respectively. Evidently, the methanolic extracts from the three different leaves were superior over the water extracts in scavenging DPPH radicals. The evidence of *T. catappa* scavenging effect on DPPH radical is consistent with our results where 50% effect on DPPH radicals was at concentration of 11.36 µg/ml. Significant antioxidant properties were already described for different plant parts of *T. catappa* in various studies (Chyau et al., 2002; 2006; Kinoshita et al., 2007; Ko et al., 2002; Lin et al., 1997; 1998; 2001; Mau et al., 2003). Despite popular use of this species in traditional medicines world widely (Morton, 1985), regarding result of this inventory, *T. catappa* is more frequently used as an ornamental and shady tree than for its medicinal properties in Coronel Portillo Province. However, several respondents described infusion prepared from leaves of *T. catappa* as medicine for diabetes treatment.

Remarkable antioxidant effect has been performed by *Triplaris peruviana*, but previous data on antioxidant properties are lacking and only pure ethnomedicinal information was recorded throughout this inventory.

Published data on antioxidant properties of *Uncaria tomentosa* indicate that the decoction is a very good scavenger of hydroxyl radical and in a lesser extension of hydrogen peroxide and hypochlorous acid (Gonçalves et al., 2005). Efficient peroxyl and superoxide scavenging activities were described (Gonçalves et al., 2005; Pilarski et al.,

2006). A strong protective effect on membrane lipids against oxidation was observed (Gonçalves et al., 2005). *U. tomentosa* decoction promptly reacted with DPPH leading to a loss of 70% in absorbance intensity (Gonçalves et al., 2005). Freeze-dried cat's claw extract was effective scavenger of DPPH (EC_{50} 18 mg/ml) (Sandoval et al., 2000). Above mentioned data support results obtained in this work, where the ethanols extract demonstrated good scavenging ability (EC_{50} 7.90 mg/ml).

Though, all respondents described identical indications for both studied *Uncaria* species *U. tomentosa* is markedly more used in Coronel Portillo Province. Higher antioxidant and anti-inflammatory effects were reported for *U. guianensis* (Sandoval et al., 2002).

The extracts of *Abuta grandifolia, Caesalpinia spinosa, Cordia alliodora*, *Dipteryx micrantha, Equisetum giganteum* and *Piper aduncum* showed perceptibly lower DPPH scavenger effects than *R. officinalis* extract used as a standard. Despite, collected ethnomedicinal information on these species used to treat diseases often connected to oxidative stress there are no previous reports on their antioxidant activity. More than 40% of respondents consider decoction of *A. grandifolia* as an effective remedy for treatment of diabetes. *C. spinosa* was found to be the least active in this screening, while in Peruvian folk medicine is widely used in healing of vocal chords' inflammations. *C. alliodora* and *D. micrantha* are employed as curing agents of arthritis and rheumatism. *E. giganteum* and *P. aduncum* are commonly sold in Pucallpa market for treatment of kidney disorders and decoction of *P. aduncum* is recommended for healing of various inflammations.

7. Conclusion

Antioxidant screening of fourteen Peruvian medicinal plants, selected based on their relevant ethnomedical use, has provided various extracts with significant antioxidant activity, supporting the popular traditional use of these species in Coronel Portillo Province. Whereas, the results of our screening confirmed previously published data on antioxidant activities of some species (*Phyllanthus amarus*, *Terminalia catappa* and *Uncaria tomentosa*), for some plants, namely *Abuta grandifolia, Caesalpinia spinosa, Calycophyllum spruceanum, Cordia alliodora*, *Dipteryx micrantha, Equisetum giganteum, Maytenus macrocarpa, Naucleopsis glabra*, *Piper aduncum, Pterocarpus rohrii* and *Triplaris peruviana* it was first report on their antioxidant effects.

The ethanol extracts of *C. spruceanum, N. glabra, T. peruviana* and *P. amarus* exhibited the most promissing results with even stronger activity than *Rosmarinus officinalis*, plant with well documented significant antioxidant activity, suggesting their potential use in food or pharmaceutical industry for development of new antioxidant effective herbal-based nutraceuticals, functional foods, food additives and pharmaceutical preparations. However, since detailed toxicological and clinical studies on these species are almost missing, further pharmacological studies are required for verification of health beneficial properties of these plants.

8. References

Agbor G.A., Vinson J.A., Oben J.E., Ngogang J.Y. (2007) *In vitro* antioxidant activity of three *Piper* species. Journal of Herbal Pharmacotherapy 7 (2): 49-64.

Akesson C., Lindgren H., Pero R.W., Leanderson T., Ivars F. (2003). An extract of *Uncaria tomentosa* inhibiting cell division and NF-$_K$B activity without inducing cell death. International Immunopharmacology 3 (13-14): 1889–1900.

Almela L., Sánchez-Muñoz B., Fernández-López J.A., Roca M.J., Rabe V. (2006) Liquid chromatograpic–mass spectrometric analysis of phenolics and free radical scavenging activity of rosemary extract from different raw material. Journal of chromatography A 1120 (1-2): 221-229.

Alzerreca A., Hart G. (1982) Molluscicidal Steroid Glycoalkaloids Possessing Stereoisomeric Spirosolane Structures. Toxicology Letters 12 (2-3): 151-155.

Amarowicz R., Pegg R.B., Rahimi-Moghaddam P. (2004) Free-radical scavenging capacity and antioxidant activity of selected plant species from the Canadian prairies. Food Chemistry 84 (4): 551-562.

Anesini C., Perez C. (1993) Screening of plants used in Argentine folk medicine for antimicrobial activity. Journal of Ethnopharmacology 39(2): 119-128.

Aquino R., DeSimone F., Pizza C., Conti C., Stein M.L. (1989) Plant metabolites - Structure and *in vitro* antiviral activity of quinovic acid glycosides from *Uncaria tomentosa* and *Guettarda platypoda*. Journal of Natural Products 52 (4): 679-685.

Aquino R., de Feo V., de Simone F., Pizza C., Cirino G. (1991) Plant metabolites: New compounds and antiinflammatory activity of *Uncaria tomentosa.* Journal of Natural Products 54 (2): 453-459.

Arévalo G.V. (1994) Las Plantas Medicinales y su Beneficio en la Salud Shipibo-Conibo. AIDESEP, Lima, Peru.

Barros M.E., Schor N., Boim M.A. (2003) Effects of an aqueous extract from *Phyllantus niruri* on calcium oxalate crystallization *in vitro*. Urological Research 30 (6): 374-9.

Basso L.A., da Silva L.H.P., Fett-Neto A.G., Junior W.F.D., Moreira I.D., Palma M.S. et al. (2005) The use of biodiversity as source of new chemical entities against defined molecular targets for treatment of malaria, tuberculosis, and T-cell mediated diseases - A Review. Memorias do Instituto Oswaldo Cruz 100 (6): 575-606.

Bastien J.W., Stauffer E.F. (1987) Healers of the Andes: Kallawaya Herbalists and Their Medicinal Plants. University of Utah Press, Texas, USA.

Batista J.M., Lopes A.A., Ambrósio D.L., Regasini L.O., Kato M.J., Bolzani Vda S., Cicarelli R.M., Furlan M. (2008) Natural chromenes and chromene derivatives as potential anti-trypanosomal agents. Biological and Pharmaceutical Bulletin 31 (3): 538-40.

Bhattacharjee R., Sil P.C. (2007) Protein isolate from the herb, *Phyllanthus niruri* L. (*Euphorbiaceae*), plays hepatoprotective role against carbon tetrachloride induced liver damage via its antioxidant properties. Food and Chemical Toxicology 45 (5): 817-826.

Blois M.S. (1958) Antioxidant determinations by the use of a stable free radical. Nature 181: 1199–1200.

Bork P.M., Schmitz M.L., Weimann C., Kist M., Heinrich M. (1996) Nahua Indian medicinal plants (Mexico): Inhibitory activity on NF-kappa B as an anti-inflammatory model and antibacterial effects. Phytomedicine 3 (3): 263-269.

Bourdy G., Oporto P., Gimenez A., Deharo E. (2004) A search for natural bioactive compounds in Bolivia through a multidisciplinary approach Part VI. Evaluation of the antimalarial activity of plants used by Isoceño-Guaraní Indians. Journal of Ethnopharmacology 93 (2): 269-277.

Brack A.E. (1999) Diccionario enciclopédico de plantas útiles del Perú. Centro "Bartolome de las Casas", Cusco, Peru.

Braga F.G., Bouzada M.L., Fabri R.L., de O Matos M., Moreira F.O., Scio E., Coimbra E.S. (2007) Antileishmanial and antifungal activity of plants used in traditional medicine in Brazil. Journal of Ethnopharmacology 111 (2): 396-402.

Brito A.R., Brito A.A.. (1993) Forty years of Brazilian medicinal plant research. Journal of Ethnopharmacology 39 (1): 53-67.

Bruni R., Rossi D., Muzzoli M., Romagnoli C., Paganetto G., Besco E., Choquecillo F., Peralta K., Schmitt W.L., Sacchetti G. (2006) Antimutagenic, antioxidant and antimicrobial properties of *Maytenus krukovii* bark. Fitoterapia 77 (7-8): 538-545.

Bussmann R. W., Sharon D. (2006) Traditional medicinal plant use in Northern Peru: tracking two thousand years of healing culture. Journal of Ethnobiology and Ethnomedicine 2 (1): 47.

Caceres A., Giron L.M., Martinez A.M. (1987) Diuretic Activity of Plants Used for the Treatment of Urinary Ailments in Guatemala. Journal of Ethnopharmacology 19 (3): 233-245.

Caceres A., Menendez H., Mendez E., Cohobon E., Samayoa B.E., Jauregui E., Peralta E., Carrillo G. (1995) Antigonorrhoeal Activity of Plants Used in Guatemala for the Treatment of Sexually-Transmitted Diseases. Journal of Ethnopharmacology 48 (2): 85-88.

Calixto J.B., Yunes R.A., Neto A.S., Valle R.M., Rae G.A. (1984) Antispasmodic effects of an alkaloid extracted from *Phyllanthus sellowianus*: a comparative study with papaverine. Brazilian Journal of Medical and Biological Research 17 (3-4): 313-21.

Campos A.H., Schor N. (1999) *Phyllanthus niruri* inhibits calcium oxalate endocytosis by renal tubular cells: its role in urolithiasis. Nephron 81 (4): 393-7.

Cardona Zuleta L.M., Cavalheiro A.J., Siqueira Silva D.H., Furlan M., Marx Young M.C., Albuquerque S., Castro-Gamboa I., da Silva Bolzani V. (2003) Seco-iridoids from *Calycophyllum spruceanum* (*Rubiaceae*). Phytochemistry 64 (2): 549-53.

Cetto A.A., Wiedenfeld H., Revilla M.C., Sergio I.A. (2000) Hypoglycemic effect of *Equisetum myriochaetum* aerial parts on streptozotocin diabetic rats. Journal of Ethnopharmacology 72 (1-2): 129-133.

Chatterjee M., Sarkar K., Sil P.C. (2006) Herbal (*Phyllanthus niruri*) protein isolate protects liver from nimesulide induced oxidative stress. Pathophysiology 13 (2): 95-102.

Chatterjee S., Niaz Z., Gautam S., Adhikari S., Variyar P.S., Sharma A. (2007) Antioxidant activity of some phenolic constituents from green pepper (*Piper nigrum* L.) and fresh nutmeg mace (*Myristica fragrans*). Food Chemistry 101 (2): 515-523.

Chávez H., Callo N., Estevez-Braun A., Ravelo A.G., Gonzalez A.G. (1999) Sesquiterpene polyol esters from the leaves of *Maytenus macrocarpa*. Journal of Natural Products 62 (11): 1576-1577.

Chávez H., Estévez-Braun A., Ravelo A.G., González A.G. (1998) Friedelane triterpenoids from *Maytenus macrocarpa*. Journal of Natural Products 61 (1): 82-5.

Chávez H., Rodríguez G., Estévez-Braun A., Ravelo A.G., Estévez-Reyes R., González A.G., Fdez-Puente J.L., García-Grávalos D. (2000) Macrocarpins A-D, new cytotoxic nor-triterpenes from *Maytenus macrocarpa*. Bioorganic and Medicinal Chemistry Letters 10 (8): 759-62.

Chen T.K., Ales D.C., Baenziger N.C., Wiemer D.F. (1983) Ant-repellent triterpenoids from *Cordia alliodora*. Journal of Organic Chemistry 48 (20): 3525-3531.

Choudhary D., Kale R.K. (2002) Antioxidant and non-toxic properties of *Piper betle* leaf extract: *in vitro* and *in vivo* studies. Phytotherapy Research 16 (5): 461-6.

Chu S.C., Yang S.F., Liu S.J., Kuo W.H., Chang Y.Z., Hsieh Y.S. (2007) *In vitro* and *in vivo* antimetastatic effects of *Terminalia catappa* L. leaves on lung cancer cells. Food and Chemical Toxicology 45 (7): 1194-201.

Chyau C.C., Ko P.T., Mau J.L. (2006) Antioxidant properties of aqueous extracts from *Terminalia catappa* leaves. LWT - Food Science and Technology 39 (10) 1099-1108.

Chyau C.C., Tsai S.Y., Ko P.T., Mau J.L. (2002) Antioxidant properties of solvent extracts from *Terminalia catappa* leaves. Food Chemistry 78 (4): 483-488.

CIA (2008) The world fact book. Available online: https://www.cia.gov/library/publications/the-world-factbook/geos/pe.html access date: 10.3.2008.

Ciccia G., Coussio J., Mongelli E. (2000) Insecticidal activity against *Aedes aegypti* larvae of some medicinal South American plants. Journal of Ethnopharmacology 72 (1-2): 185-189.

Cipollini M.L., Levey D.J. (1997) Antifungal activity of *Solanum* fruit glycoalkaloids: Implications for frugivory and seed dispersal. Ecology 78 (3): 799-809.

Clavo M., Seijas Z., Alegre J. (2003) Plantas medicianles usadas por mujeres nativas y mestizas en la region Ucayali. Pucallpa, Peru

Correia H., Gonzalez-Paramas A., Amaral M.T., Santos-Buelga C., Batista M.T.(2005) Characterisation of polyphenols by HPLC-PAD-ESI/MS and antioxidant activity in *Equisetum telmateia*. Phytochemical analysis 16 (5): 380-387.

Davidson J. (1983) The survival of traditional medicine in a Peruvian Barriada. Social Science and Medicine 17: 1271-1280.

de Feo V. (1992) Medicinal and magical plants in the Northern Peruvian Andes. Fitoterapia 63 (4): 417-441.

de Feo V. (2003) Ethnomedical field study in Northern Peruvian Andes with particular reference to divination practices. Journal of Ethnopharmacology 85 (2-3): 243-256.

De-la-Cruz H., Vilcapoma G., Zevallos P.A. (2007) Ethnobotanical study of medicinal plants used by the Andean people of Canta, Lima, Peru. Journal of Ethnopharmacology 111 (2): 284-294.

Desmarchelier C., Gurni A., Ciccia G., Giulietti A.M. (1996 a) Ritual and medicinal plants of the Ese'ejas of the Amazonian rainforest (Madre de Dios, Peru). Journal of Ethnopharmacology 52 (1): 45-51.

Desmarchelier C., Mongelli E., Coussio J., Ciccia G. (1996 b) Studies on the cytotoxicity, antimicrobial and DNA-binding activities of plants used by the Ese'ejas. Journal of Ethnopharmacology 50 (2): 91-96.

Desmarchelier C., Mongelli E., Coussio J., Ciccia G. (1997) Evaluation of the *in vitro* antioxidant capacity in extracts of *Uncaria tomentosa* (Willd.) DC. Phytotherapy Research 11 (3): 254-256.

Desmarchelier C., Schaus F.W. (2000) Sixty medicinal plants from the Peruvian Amazon. privately published, Lima, Peru.

Duke J.A. (1981) Handbook of Legumes of World Economic Importance. Plenum Press, New York, USA.

Duke, J.A. (1992) Handbook of biologically active phytochemicals and their activities. CRC Press, Boca Raton, Fla.

Dunstan C.A., Noreen Y., Serrano G., Cox P.A., Perera P., Bohlin L. (1997) Evaluation of some Samoan and Peruvian medicinal plants by prostaglandin biosynthesis and rat ear oedema assays. Journal of Ethnopharmacology 57 (1): 35-56.

Eberlin S., dos Santos L.M.B., Queiroz M.L.S. (2005) *Uncaria tomentosa* extract increases the number of myeloid progenitor cells in the bone marrow of mice infected with *Listeria monocytogenes*. International Immunopharmacology 5 (7-8): 1235-1246.

Fan Y.M., Xu L.Z., Gao J., Wang Y., Tang X.H., Zhao X.N., Zhang Z.X. (2004) Phytochemical and antiinflammatory studies on *Terminalia catappa*. Fitoterapia 75 (3-4): 253-260.

Farouk A., Almagboul A.Z., Bashir A.K. (1983) Antimicrobial activity of certain Sudanese plants used in folkloric medicine. Screening for antibacterial activity (I). Fitoterapia 54 (1): 3-7.

Ferreira J.C., Cardoso M.G., de Souza P.E., Miranda J.C., Barreto S.S. (2005) Inhibitory effect of *Caesalpinia spinosa* leaflets crude extract on *Fusarium solani* and *Phoma tarda*. Acta Scientiarum Biological Sciences 27(2): 185-188.

Foti M.C., Daquino C., Geraci C. (2004) Electron-transfer reaction of cinnamic acids and their methyl esters with the DPPH radical in alcoholic solutions. The Journal of Organic Chemistry 69 (7): 2309–2314.

Fujisaka S., Escobar G., Veneklaas E.J. (2000) Weedy fields and forests: interactions between land use and the composition of plant communities in the Peruvian Amazon. Agriculture, Ecosystems and Environment 78 (2): 175–186.

Gali-Muhtasib H.U., Yamout S.Z., Sidani M.M. (2000) Tannins protect against skin tumour promotion induced by ultraviolet-B radiation in hairless mice. Nutrition and Cancer 37(1): 73-7.

Gao J., Tang X.H., Dou H., Fan Y.M., Zhao X.N., Xu Q. (2004) Hepatoprotective activity of *Terminalia catappa* L. leaves and its two triterpenoids. Journal of Pharmacy and Pharmacology 56 (11): 1449-1455.

Garavito G, Rincón J, Arteaga L, Hata Y, Bourdy G, Gimenez A, Pinzón R, Deharo E. (2006) Antimalarial activity of some Colombian medicinal plants. Journal of Ethnopharmacology 107 (3): 460-2.

Garcia R., Cayunao C., Bocic R., Backhouse N., Delporte C., Zaldivar M. (2005) Antimicrobial activity of isopteropodine. Zeitschrift fur Naturforschung C-A Journal of Biosciences 60 (5-6): 385-388.

Gonçalves C., Dinis T., Batista M.T. (2005) Antioxidant properties of proanthocyanidins of *Uncaria tomentosa* bark decoction: a mechanism for anti-inflammatory activity. Phytochemistry 66 (1): 89-98.

Goun E., Cunningham G., Chu D., Nguyen C., Miles D. (2003) Antibacterial and antifungal activity of Indonesian ethnomedical plants. Fitoterapia 74 (6): 592-596.

Goy J., Waltner-Toews D. (2005) Improving Health in Ucayali, Peru: A Multisector and Multilevel Analysis. EcoHealth 2 (1): 47-57.

Graham J.G., Pendland S.L., Prause J.L., Danzinger L.H., Vigo J.S., Cabieses F., Farnsworth N.R. (2003) Antimycobacterial evaluation of Peruvian plants. Phytomedicine 10 (6-7): 528-535.

Gugler R., Dengler H.J. (1973) Drugs interacting with coumarine oral anticoagulants. Klinische Wochenschrift 51 (22): 1081-1090.

Gutteridge J.M.C. (1994) Biological origin of free radicals, and mechanisms of antioxidant protection. Chemico–Biological Interactions 91 (2-3): 133–140.

Halliwell B. (1997) Antioxidants: the basics–what they are and how to evaluate them. Advances in Pharmacology 38 (1): 3–20.

Halliwell B., Gutteridge J.M.C. (1999). Free radicals in biology and medicine (3rd ed). Oxford: Oxford University Press.

Hammond G.B., Fernandez I.D., Villegas L.F., Vaisberg A.J. (1998) A survey of traditional medicinal plants from the Callejon de Huaylas, Department of Ancash, Peru. Journal of Ethnopharmacology 61 (1): 17-30.

Hardin S.R. (2007) Cat's claw: an Amazonian vine decreases inflammation in osteoarthritis. Complementary Therapies in Clinical Practice 13 (1): 25-8.

Harikumar K.B., Kuttan R. (2007) An extract of *Phyllanthus amarus* protects mouse chromosomes and intestine from radiation induced damages. Journal of Radiation Research 48 (6): 469-76.

Harish R., Shivanandappa T. (2006) Antioxidant activity and hepatoprotective potential of *Phyllanthus niruri*. Food Chemistry 95 (2): 180-185.

Heitzman M.E., Neto C.C., Winiarz E., Vaisberg A.J., Hammond G.B. (2005) Ethnobotany, phytochemistry and pharmacology of *Uncaria* (*Rubiaceae*). Phytochemistry 66 (1): 5-29.

Hidayatulfathi O., Sallehuddin S., Ibrahim J. (2004) Adulticidal activity of some Malaysian plant extracts against *Aedes aegypti* Linnaeus. Tropical Biomedicine 21 (2): 61-7.

Ioset J.R., Marston A., Gupta M.P., Hostettmann K. (2000) Antifungal and larvicidal compounds from the root bark of *Cordia alliodora*. Journal of Natural Products 63 (3): 424-426.

Jovel E.M., Cabanillas J., Towers G.H.N. (1996) An ethnobotanical study of the traditional medicine of the Mestizo people of Suni Mirano, Loreto, Peru. Journal of Ethnopharmacology 53 (3): 149-156.

Karthikeyan J., Rani P. (2003) Enzymatic and non-enzymatic antioxidants in selected *Piper* species. Indian Journal of Experimental Biology 41 (2): 135-40.

Keplinger K., Laus G., Wurm M., Dierich M.P., Teppner H. (1999) *Uncaria tomentosa* (Willd.) DC. - Ethnomedicinal use and new pharmacological, toxicological and botanical results. Journal of Ethnopharmacology 64 (1): 23-34.

Kim Y.C., Che Q.M., Gunatilaka A.A.L., Kingston D.G.I. (1996) Bioactive steroidal alkaloids from *Solanum umbelliferum*. Journal of Natural Products 59 (3): 283-285.

Kinoshita S., Inoue Y., Nakama S., Ichiba T., Aniya Y. (2007) Antioxidant and hepatoprotective actions of medicinal herb, *Terminalia catappa* L. from Okinawa Island and its tannin corilagin. Phytomedicine 14 (11): 755-762.

Kloucek P.; Polesny Z.; Svobodova B.; Vlkova E.; Kokoska L. (2005). Antibacterial screening of some Peruvian medicinal plants used in Callería Discrit. Journal of Ethnopharmacology 99(2):309-12.

Kloucek P., Svobodova B., Polesny Z., Langrova I., Smrcek S., Kokoska L. (2007) Antimicrobial activity of some medicinal barks used in Peruvian Amazon. Journal of Ethnopharmacology 111 (2): 427-9.

Ko T.F., Weng Y.M., Chiou R.Y. (2002) Squalene content and antioxidant activity of *Terminalia catappa* leaves and seeds. Journal of Agricultural and Food Chemistry 50 (19): 5343-8.

Kumar K.B., Kuttan R. (2004) Protective effect of an extract of *Phyllanthus amarus* against radiation-induced damage in mice. Journal of Radiation Research 45 (1):1 33-9.

Kumaran A., Karunakaran R.J. (2007) *In vitro* antioxidant activities of methanol extracts of five Phyllanthus *species* from India. LWT - Food Science and Technology 40 (2): 344-352.

Kvist L.P., Christensen S.B., Rasmussen H.B., Mejia K., Gonzalez A. (2006) Identification and evaluation of Peruvian plants used to treat malaria and leishmaniasis. Journal of Ethnopharmacolgy. 106 (3): 390-420.

Laurens A., Fourneau C., Hocquemiller R., Cavé A., Bories C., Loiseau P. (1997) Antivectorial activities of cashew nut shell extracts from *Anacardium occidentale* L. Phytotherapy Research 11: 145-146.

Lentz D.L., Clark A.M., Hufford C.D., Meurer-Grimes B., Passreiter C.M., Cordero J. Ibrahimi O., Okunade A.L. (1998) Antimicrobial properties of Honduran medicinal plants. Journal of Ethnopharmacology 63 (3): 253-263.

Lewis W.H., Lamas G., Vaisberg A., Corley D.G., Sarasara C. (1999) Peruvian medicinal plant sources of new pharmaceuticals (International Cooperative Biodiversity Group-Peru). Pharmaceutical Biology 37: 69-83.

Li P., Matsunaga K., Ohizumi Y. (1999) Enhancement of the nerve growth factor-mediated neurite outgrowth from PC12D cells by Chinese and Paraguayan medicinal plants. Biological and Pharmaceutical Bulletin 22 (7):752-5.

Lim Y.Y., Murtijaya J. (2007) Antioxidant properties of *Phyllanthus amarus* extracts as affected by different drying methods. LWT - Food Science and Technology 40 (9): 1664-1669.

Lin C.C., Chen Y.L., Lin J.M., Ujiie T. (1997) Evaluation of the antioxidant and hepatoprotective activity of *Terminalia catappa*. American Journal of Chinese Medicine 25 (2): 153-161.

Lin C.C., Hsu Y.F., Lin T.C., Hsu F.L., Hsu H.Y. (1998) Antioxidant and hepatoprotective activity of punicalagin and punicalin on carbon tetrachloride-induced liver damage in rats. The Journal of pharmacy and pharmacology 50 (7): 789-94.

Lin C.C., Hsu Y.F., Lin T.C., Hsu H.Y. (2001) Antioxidant and hepatoprotective effects of punicalagin and punicalin on acetaminophen-induced liver damage in rats. Phytotherapy Research 15 (3): 206-12.

Lohezic-Le D.F., Bakhtiar A., Bezivin C., Amoros M., Boustie J. (2002) Antiviral and cytotoxic activities of some Indonesian plants. Fitoterapia 73 (5): 400-405.

Luna L.E. (1984) The healing practices of a Peruvian shaman. Journal of Ethnopharmacology 11 (2): 123-133.

MacDonald-Wicks L.K., Wood L.G., Garg M.L. (2006) Methodology for the determination of biological antioxidant capacity *in vitro*: a review. Journal of the Science of Food and Agriculture 86:2046–2056.

Macia M.J., Garcia E., Vidaurre P.J. (2005) An ethnobotanical survey of medicinal plants commercialized in the markets of La Paz and El Alto, Bolivia. Journal of Ethnopharmacology 97 (2): 337-350.

Martin G.J. (2004) Ethnobotany: A Methods Manual (Paperback), Earthscan Publications.

Martínez S.R. (1996) Phytosociological Research Center, Spain. Available online: <http://www.globalbioclimatics.org/plot/pe-pucal.htm> access date: 10.3.2008.

Matsunaga K., Sasaki S., Ohizumi Y. (1997) Excitatory and inhibitory effects of Paraguayan medicinal plants *Equisetum giganteum*, *Acanthospermum australe*, *Allophylus edulis* and *Cordia salicifolia* on contraction of rabbit aorta and guinea-pig left atrium. Natural Medicines 51: 478-481.

Mau J.L., Ko P.T., Chyau C.C. (2003) Aroma characterization and antioxidant activity of supercritical carbon dioxide extracts from *Terminalia catappa* leaves. Food Research International 36 (1): 97-104.

Mazumder A., Mahato A., Mazumder R. (2006) Antimicrobial potentiality of *Phyllanthus amarus* against drug resistant pathogens. Natural Product Research 20 (4): 323-326.

Middleton E., Kandaswami C., Theoharides T.C. (2000) The effects of plant flavonoids on mammalian cells: Implications for inflammation, heart disease, and cancer. Pharmacological Reviews 52 (4): 673-751.

Micali S., Sighinolfi M.C., Celia A., De Stefani S., Grande M., Cicero A.F., G. Bianchi (2006) Can *Phyllanthus niruri* affect the efficacy of extracorporeal shock wave lithotripsy for renal stones? A Randomized, Prospective, Long-Term Study. The Journal of Urology 176 (3): 1020-1022.

Miliauskas G., Venskutonis P.R., van Beek T.A. (2004) Screening of radical scavenging activity of some medicinal and aromatic plant extracts. Food Chemistry 85 (2): 231-237.

Miller M.J., Angeles F.M., Reuter B.K., Bobrowski P., Sandoval M. (2001) Dietary antioxidants protect gut epithelial cells from oxidant-induced apoptosis. BMC Complementary and Alternative Medicine 1: 11.

Morton J.F. (1985) Indian almond (*Terminalia catappa*), salt tolerant, useful, tropical tree with nut worthy of improvement. Economic Botany 39 (2): 101-112.

Naaz F., Javed S., Abdin M.Z. (2007) Hepatoprotective effect of ethanolic extract of *Phyllanthus amarus* Schum. et Thonn. on aflatoxin B_1-induced liver damage in mice. Journal of Ethnopharmacology 113 (3): 25 503-509.

Nagappa A.N., Thakurdesai P.A., Rao N.V., Singh J. (2003) Antidiabetic activity of *Terminalia catappa* Linn fruits. Journal of Ethnopharmacology 88:1, 45-50.

Navickiene H.M.D., Morandim A.D.A., Alecio A.C., Regasini L.O., Bergamo D.C.B., Telascrea M. (2006) Composition and antifungal activity of essential oils from *Piper aduncum*, *Piper arboreum* and *Piper tuberculatum*. Quimica Nova 29 (3): 467-470.

Nunez V., Otero R., Barona J., Saldarriaga M., Osorio R.G., Fonnegra R. (2004) Neutralization of the edema-forming, defibrinating and coagulant effects of *Bothrops asper* venom by extracts of plants used by healers in Colombia. Brazilian Journal of Medical and Biological Research 37 (7): 969-977.

Odar C.A.P., Rodríguez C.V. (2004) Boletin Meteorologico, Universidad Nacional de Ucayali, Pucallpa, Peru.

Okunade A.L., Hufford C.D., Clark A.M., Lentz D. (1997) Antimicrobial properties of the constituents of *Piper aduncum*. Phytotherapy Research 11 (2): 142-144.

Okusa P.N., Penge O., Devleeschouwer M., Duez P. (2007) Direct and indirect antimicrobial effects and antioxidant activity of *Cordia gilletii* De Wild (*Boraginaceae*). Journal of Ethnopharmacology 112 (3): 476-481.

Orjala J., Erdelmeier C.A.J., Wright A.D., Rali T., Sticher O. (1993) 5 new prenylated p-hydroxybenzoic acid-derivatives with antimicrobial and molluscicidal activity from *Piper aduncum* leaves. Planta Medica 59 (6): 546-551.

Orjala J., Wright A.D., Behrends H., Folkers G., Sticher O., Ruegger H., Rali T. (1994) Cytotoxic and antibacterial dihydrochalcones from *Piper Aduncum*. Journal of Natural Products 57 (1): 18-26.

Paulová H., Bochořáková H., Táborská E. (2004) Metody stanovení antioxidační aktivity přírodních látek *in vitro*. Chemické Listy 98: 174-179.

Pawar S.P., Pal S.C. (2002) Antimicrobial activity of extracts of *Terminalia catappa* root. Indian Journal of Medical Sciences 56 (6): 276-278.

Perez Gutierrez R.M., Yescas Laguna G., Walkowski A. (1985) Diuretic activity of Mexican equisetum. Journal of Ethnopharmacology 14: 269-272.

Perez-Victoria J.M., Tincusi B.M., Jimenez I.A., Bazzocchi I.L., Gupta M.P., Castanys S., Gamarro F., Ravelo A.G. (1999) New natural sesquiterpenes as modulators of daunomycin resistance in a multidrug-resistant *Leishmania tropica* line. Journal of Medicinal Chemistry 42 (21): 4388-4393.

Pilarski R., Zielinski H., Ciesiołka D., Gulewicz K. (2006) Antioxidant activity of ethanolic and aqueous extracts of *Uncaria tomentosa* (Willd.) D C. Journal of Ethnopharmacology 104 (1-2): 18-23.

Pimental L.E.V., Rengifo E.B., Portomisniski R.L. (2004) Gran Enciclopedia de la Región Ucayali. Lima, Peru.

Pinedo M., Rengifo E., Cerruti T. (1997) Plantas medicinales de la Amazonía Peruana - Estudio de su uso y cultivo. Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru.

Polia M.M. (1988) Las Lagunas de los Encantos. Medicina Tradicional Andina del Peru Septentrional. Cepeser, Piura, Peru.

Portillo A., Vila R., Freixa B., Adzet T., Canigueral S. (2001) Antifungal activity of Paraguayan plants used in traditional medicine. Journal of Ethnopharmacology 76 (1): 93-98.

Pramyothin P., Ngamtin C., Poungshompoo S., Chaichantipyuth C. (2007) Hepatoprotective activity of *Phyllanthus amarus* Schum. et. Thonn. extract in ethanol treated rats: *in vitro* and *in vivo* studies. Journal of Ethnopharmacology 114 (2): 169-73.

Prance G.T., Silva M.F. (1975) Arvores de Manaus. INPA, Manaus, Brazil.

Quiroga E.N., Vattuone M.A. (2001) Screening antifungal activities of selected medicinal plants. Journal of Ethnopharmacology 74 (1): 89-96.

Rahalison L., Hamburger M., Hostettmann K., Monod M., Frenk E. (1991) A bioautographic agar overlay method for the detection of antifungal compounds from higher plants. Phytochemical Analysis 2 (5): 199-203.

Rathee J.S., Patro B.S., Mula S., Gamre S., Chattopadhyay S. (2006) Antioxidant activity of piper betel leaf extract and its constituents. Journal of Agricultural and Food Chemistry 54 (24): 9046-54.

Raul R. (2000) Peru, Country Pasture/Forage Resource Profiles. FAO. Available online: <http://www.fao.org/ag/agp/agpc/doc/counprof/peru/peru.htm> access date: 10.3.2008.

Reis S.R., Valente L.M., Sampaio A.L., Siani A.C., Gandini M., Azeredo E.L., D'Avila L.A., Mazzei J.L., Henriques M.G., Kubelka C.F. (2008) Immunomodulating and antiviral activities of *Uncaria tomentosa* on human monocytes infected with Dengue Virus-2. International Immunopharmacology 8 (3): 468-76.

Reynel C., Pennington R.T., Pennington T.D., Flores C., Daza A. (2003) Árboles útiles de la Amazonía Peruana, un manual con apunts de identificación, ecología y propagación de las especies. Tarea Gráfica Educativa, Lima, Peru.

Rios J.L., Recio M.C. (2005) Medicinal plants and antimicrobial activity. Journal of Ethnopharmacology 100 (1-2): 80-84.

Rizzi R., Re F., Bianchi A., de Feo V., de Simone F., Bianchi L., Stivala L. (1993) Mutagenic and antimutagenic activities of *Uncaria tomentosa* and its extacts. Journal of Ethnopharmacology 38 (1): 63-77.

Rodriguez E., West J.E. (1995) International Research on Biomedicines from the Tropical Rain-Forest. Interciencia 20 (3): 140-143.

Rojas R., Bustamante B., Bauer J., Fernandez I., Alban J., Lock O. (2003) Antimicrobial activity of selected Peruvian medicinal plants. Journal of Ethnopharmacology 88 (2-3): 199-204.

Ruchi G. Marwah, Majekodunmi O. Fatope, Ramla Al Mahrooqi, Gouri B. Varma, Hussain Al Abadi, Suad Khamis S. Al-Burtamani (2007) Antioxidant capacity of some edible and wound healing plants in Oman. Food Chemistry 101 (2): 465-470.

Sanchez-Mareno C. (2002) Review: Methods used to evaluate the free radical scavenging activity in foods and biological systems. Food Science and Technology International 8 (3): 121–137.

Sandoval M., Charbonnet R.M., Okuhama N.N., Roberts J., Krenova Z., Trentacosti A.M., Miller J.S. (2000) Cat's claw inhibits TNF- α production and scavenges free radicals: role in cytoprotection. Free Radical Biology and Medicine 29 (1): 71–78.

Sandoval M., Okuhama N.N., Zhang X.J., Condezo L.A., Lao J., Angeles F.M., Musah R.A., Bobrowski P., Miller M.J.S. (2002) Anti-inflammatory and antioxidant activities of cat's claw (*Uncaria tomentosa* and *Uncaria guianensis*) are independent of their alkaloid content. Phytomedicine 9 (4): 325-337.

Santa Maria A., Lopez A., Diaz M.M., Alban J., Galan de Mera A., Orellana J.A., Pozuelo J.M. (1997) Evaluation of the toxicity of *Uncaria tomentosa* by bioassays *in vitro*. Journal of Ethnopharmacology 57 (3): 183–187.

Sarkar M.K., Sil P.C. (2007) Hepatocytes are protected by herb *Phyllanthus niruri* protein isolate against thioacetamide toxicity. Pathophysiology 14 (2): 113-120.

Schultes R.E., Raffauf R.F. (1990) The Healing Forest. Discorides Press, Portland, Oregon.

Sheng Y.Z., Pero R.W., Amiri A., Bryngelsson C. (1998) Induction of apoptosis and inhibition of proliferation in human tumor cells treated with extracts of *Uncaria tomentosa*. Anticancer Research 18 (5A): 3363-3368.

Smith A.C. (1991) Flora vitiensis nova: A new flora of Fiji. National Tropical Botanical Garden, Lawai, Kauai, Hawai'i.

Stajner D., Popović B.M., Canadanović-Brunet J., Boza P. (2006) Free radical scavenging activity of three *Equisetum* species from Fruska gora mountain. Fitoterapia 77 (7-8): 601-4.

Steele J.C.P., Simmonds M.S.J., Veitch N.C., Warhurst D.C. (1999) Evaluation of the anti-plasmodial activity of bisbenzylisoquinoline alkaloids from *Abuta grandifolia*. Planta Medica 65 (5): 413-416.

Swamy V.B.M., Ahmed S.M., Gopkumar P., Dhanapal R., Chandrashekar V.M., Rao T.S. (2006) Antidiarrhoeal activity of *Terminalia catappa* Linn. leaf extracts in rats. Asian Journal of Chemistry 18 (2) 1236-1242.

Taylor L. (2005) The Healing Power of Rain Forest. Square One Publishers, New York, USA.

Teikemeier G., Bolsen K., Merk H.E., Goerz G. (1987) Possible Anticarcinogenic Effects of Coumarine. Journal of Investigative Dermatology 89 (4): 441.

Torpocco V., Chávez H., Estévez-Braun A., Ravelo A.G. (2007) New dammarane triterpenes from *Maytenus macrocarpa*. Chemical and Pharmaceutical Bulletin 55 (5): 812-4.

Torres-Santos E.C., Moreira D.L., Kaplan M.A., Meirelles M.N., Rossi-Bergmann B. (1999 a) Selective effect of 2',6'-dihydroxy-4'-methoxychalcone isolated from *Piper aduncum* on *Leishmania amazonensis*. Antimicrobial Agents and Chemotherapy 43 (5): 1234-41.

Torres-Santos E.C., Rodrigues J.M., Moreira D.L., Kaplan M.A., Rossi-Bergmann B. (1999 b) Improvement of *in vitro* and *in vivo* antileishmanial activities of 2', 6'-dihydroxy-4'-methoxychalcone by entrapment in poly(D,L-lactide) nanoparticles. Antimicrobial Agents and Chemotherapy 43 (7): 1776-1778.

Tsai J.Y., Chou C.J., Chen C.F., Chiou W.F. (2003) Antioxidant activity of piperlactam S: prevention of copper-induced LDL peroxidation and amelioration of free radical-induced oxidative stress of endothelial cells. Planta Medica 69 (1): 3-8.

Vanisree M., Kavitha J., Subbaraju G.V. (2002) Synthesis of methyl 3-(2,4,5-trimethoxyphenyl)-propionate, an antifungal and larvicidal constituent of *Cordia alliodora*. Asian Journal of Chemistry 14(1): 534-536.

Vasquez, M.R. (1997) Flórula de las Reservas Biológicas de Iquitos, Perú. Missouri Botanical Garden, Missouri, USA 1997.

Vellosa J.C.R., Khalil N.M., Formenton V.A.F., Ximenes V.F., Fonseca L.M., Furlan M., Brunetti I.L., Oliveira O.M.M.F. (2006) Antioxidant activity of *Maytenus ilicifolia* root bark. Fitoterapia 77 (3): 243-244.

Vijayakumar R.S., Surya D., Nalini N. (2004) Antioxidant efficacy of black pepper (*Piper nigrum* L.) and piperine in rats with high fat diet induced oxidative stress. Redox Report: Communications in free radical research 9 (2): 105-10.

Wagner W.L., Herbst D.L. (1999) Manual of the flowering plants of Hawai'i. University of Hawai'i Press, Honolulu.

Waller D.P. (1993) Methods in ethnopharmacology. Journal of Ethnopharmacology 38 (2-3): 181-188.

Waterhouse B. M., Mitchell A. A. (1998) Northern Australia quarantine strategy weeds target list. Quarantine and Inspection Service. Miscellaneous Publication 6: 59-60.

Welman W.G. (2003) The genus *Solanum* (*Solanaceae*) in southern Africa: subgenus *Leptostemonum*, the introduced sections Acanthophora and Torva. Bothalia 33 (1): 1-18.

Wood L.G., Gibson P.G., Garg M.L. (2006) A review of the methodology for assessing *in vivo* antioxidant capacity. Journal of the Science of Food and Agriculture 86: 2057–2066.

Yamaguchi L.F., Lago J.H., Tanizaki T.M., Mascio P.D., Kato M.J. (2006) Antioxidant activity of prenylated hydroquinone and benzoic acid derivatives from *Piper crassinervium* Kunth. 67 (16): Phytochemistry 1838-43.

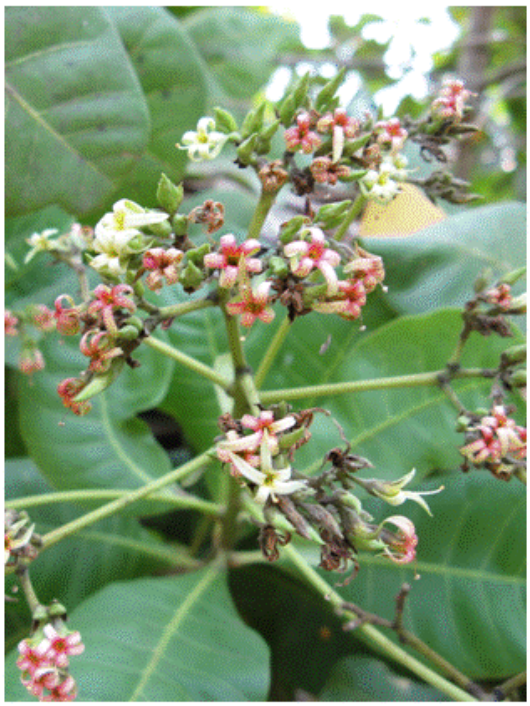
Zhu G.H., Croat T.B. (2004) Revision of *Dracontium* (*Araceae*). Annals of the Missouri Botanical Garden 91 (4): 593-667.

Appendices A.

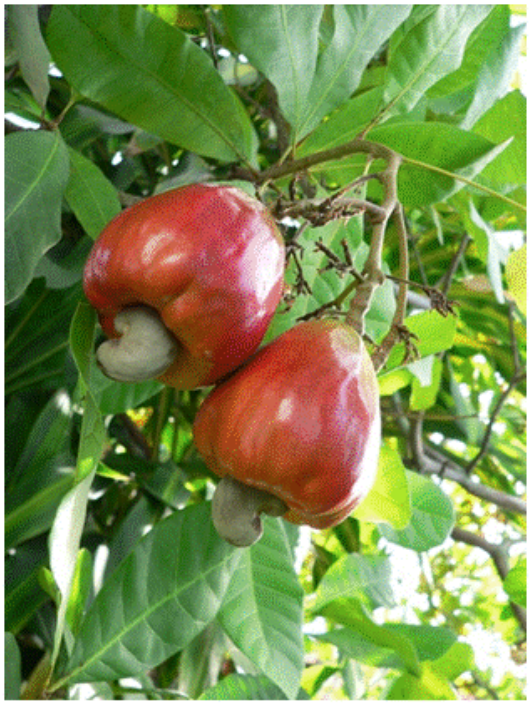
Appendix 1: *Abuta grandifolia*

Appendix 2. *Abuta grandifolia*- inflorescence

Appendix 3: *Anacardium occidentale*- inflorescence



Appendix 4: *Anacardium occidentale*- fruits



Appendix 5: *Brunfelsia grandiflora* -inflorescence

Appendix 6: *Brunfelsia grandiflora*-Fruits and flower

Appendix 7: *Caesalpinia spinosa*-inflorescence

Appendix 8: *Calycophyllum spruceanum*-trunk with peeling bark

Appendix 9: *Calycophyllum spruceanum*-branch with fruits

Appendix 10: *Copaifera paupera*-fruits

Appendix 11: *Dracontium loretense*-flower

Appendix 12: ***Equisetum giganteum***

Appendix 13: *Maytenus macrocarpa*-trunk bark

Appendix 14: *Petiveria alliacea*-leaves

Appendix 15: *Phyllanthus amarus*

Appendix 16: *Piper peltatum*

Appendix 17: *Piper aduncum*

Appendix 18: *Pterocarpus rohrii*-inflorescence

Appendix 19: *Tabebuia chrysantha*-inflorescence

Appendix 20: *Solanum mammosum*-leaf and fruit

Appendix 21: *Uncaria tomentosa*

Appendix 22: *Uncaria tomentosa*-twig with leaves

Appendix 23: *Uncaria tomentosa*-characteristical thorns

Appendix 24: *Uncaria tomentosa* and *U. guianensis*-twigs with thorns

Appendices B.

List of publications related to the thesis

Svobodova B., Kokoska L., **Kutilkova L.**, Polesny Z. Antioxidant activity of selected Peruvian medicinal plants used in Calleria District. 55th International Congress and Annual Meeting of the Society for Medicinal Plant Research, 02.09.-06.09. 2007, Graz, Austria [Published in: Planta Medica, 2007, 73 (9): 989-989; abstract P531].

Kutilkova L., Clavo M., Polesny Z., Kokoska L. Medicinal Plants Used by Local Communities in Ucayali Department, Peru: an Ethnobotanical Inventory. 11th International Congress of Ethnobiology, 25.06.-30.06. 2008, Cusco, Peru [Accepted].