

DOI: 10.5586/asbp.3485

Publication history

Received: 2015-07-12

Accepted: 2015-12-07

Published: 2016-03-31

Handling editor

Łukasz Łuczaj, Institute of Applied Biotechnology and Basic Sciences, University of Rzeszów, Poland

Authors' contributions

WeiH and CL designed this study; WeiH, PL, YL, WenH, YJ, JW, CBN, and CL conducted the field work; WeiH analyzed the data and drafted the first version of the manuscript, which was later revised by CL and approved by all authors

Funding

This study was supported by the National Natural Science Foundation of China (31161140345, 31070288), the Ministry of Education of China (B08044), the Ministry of Science and Technology (2012FY110300), and Minzu University of China (2015MDDT16C and YLXD01013).

Competing interests

No competing interests have been declared.

Copyright notice

© The Author(s) 2016. This is an Open Access article distributed under the terms of the [Creative Commons Attribution License](#), which permits redistribution, commercial and non-commercial, provided that the article is properly cited.

Citation

Huang W, Li P, Liu Y, Huang W, Ju Y, Wang J, et al. Ethnobotanical study on medicinal plants used by Li people in Ledong, Hainan Island, China. *Acta Soc Bot Pol.* 2016;85(1):3485. <http://dx.doi.org/10.5586/asbp.3485>

Digital signature

This PDF has been certified using digital signature with a trusted timestamp to assure its origin and integrity. A verification trust dialog appears on the PDF document when it is opened in a compatible PDF reader. Certificate properties provide further details such as certification time and a signing reason in case any alterations made to the final content. If the certificate is missing or invalid it is recommended to verify the article on the journal website.

ORIGINAL RESEARCH PAPER

Ethnobotanical study on medicinal plants used by Li people in Ledong, Hainan Island, China

Weijuan Huang¹, Ping Li¹, Yujing Liu¹, Wen Huang¹, Yan Ju¹, Jianjun Wang¹, Chia B. Ntumwel², Chunlin Long^{1,3*}

¹ College of Life and Environmental Sciences, Minzu University of China, Beijing 100081, PR China

² Department of Forestry, Faculty of Agronomy and Agricultural Sciences, University of Dschang, P.O. Box: 222 Dschang, Cameroon

³ Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650201, PR China

* Corresponding author. Email: long@mail.kib.ac.cn

Abstract

The paper documents on the uses of traditional medicinal plants used for treating human ailments in three villages of Ledong, a county inhabited by Li ethnic group in the southwest of Hainan Province, China. Semi-structured interviews, key informant interviews and participatory observations were used to collect ethnobotanical data from February to March 2012 and in July 2013. The data collected was analyzed using descriptive statistics. Thirty native knowledgeable people were interviewed. The Li community uses 50 plant species in 36 families for medicinal purposes. The most common medicinal plant families were Leguminosae (14%), Compositae (6%), and Euphorbiaceae (6%), and the most common preparations methods were decoction (84%), crushing (38%), and poultice (34%). The traditional medicinal plants were mainly used for hemostasis (12.9%), body pains (11.4%), gastrointestinal disorders (11.4%), and trauma (10%). Twenty-four species of medicinal plants (48%) have never been reported in the literature of Li medicines. In addition, 22 species (44%) have already been studied by researchers and their extracts or compounds were good bio-actives. However, the rapid socio-economic development in the county is the main threat to the conservation of Li medicine and has resulted in the decrease in the abundance and use of medicinal plants and associated traditional knowledge. Other factors accounting for a decrease in the use of Li medicinal plants like loss of plant diversity, change of land use, and threatened traditional knowledge were equally discussed.

Keywords

ethnobotany; traditional knowledge; ethnomedicine; Li ethnic group; medicinal plants

Introduction

Throughout history, medicinal plants have been used traditionally to treat various ailments by folk societies or ethnic groups [1]. Some traditional medical systems like Chinese, Ayurvedic, and Unani contribute to the rapid development of traditional medicines. Practitioners of ethnomedicine employ methods based on the ecological environmental, sociocultural and religious background to provide health care for local people [2,3]. These long-term traditionally used plants have shown to be relatively safer than those herbs which have no history of ethnomedical use [4]. Given that in other areas, evidence of the ethnomedicinal importance of plants for local people has been documented [5–7], a similar study was therefore necessary.

In China, 55 ethnic minorities were officially recognized in the country. Each ethnic group accumulated lots of medicinal experiences and documents as well as medical theories and applications while struggling with diseases. Ethnomedicine has a special theoretical basis as it forms the roots of ethnic cultures. To date, some ethnomedicines have been exploited and have made great contributions to the health of human beings based on their traditional knowledge [1]. For example, the famous medicine called *pseudo-ginseng* (*Panax notoginseng*, or *San-qi* in Chinese), used widely for the prevention and treatment of cardiovascular diseases [8], was firstly discovered and applied by Zhuang ethnic group. *Terminalia chebula* (*He-zi* in Chinese) is not only used often in traditional Chinese medicine (TCM), but also very popular in Tibetan medicine and has been entitled “the king of all medicines” [9]. *Paris polyphylla* (*Chong-lou* in Chinese), a traditional heat clearing and detoxifying ethnomedicine, has the effects of anti-tumor, anti-diabetic, anti-inflammatory, and inhibitory activity against platelet aggregation [10]. It has a wide distribution and is used by many ethnic groups such as Yi, Bai, Miao, Lisu, Naxi, and others [11]. Furthermore, it has been developed into the principal material of many celebrated Chinese patent medicines, such as Yunnan Baiyao, and Gongxuening capsule. However, there are still many valuable ethnomedicines to be explored and studied.

Hainan Island, located in the southern part of China, was considered the remotest place in ancient times. It belongs to the semi-arid tropical monsoon climate and has a well-defined dry season and wet season. The terrain in the east is higher than that of the west [12]. It has favorable natural and geographical conditions, and encloses numerous medicinal plant resources [13], which provides livelihood substances for many ethnic groups. The Li ethnic group was one of the first groups to reside in the area and has developed many cultural practices and customs. The Li's population is estimated at about 1.27 million, accounting for 14.65% of all populations in Hainan Province [14]. Li medicine and its related traditional knowledge were generated along with the interaction between Li people and their environment. As early as the period of Song and Yuan dynasties (960–1368), Li people had a comprehensive understanding of herbals about their forms, functions, properties, collections, processes and categories [15]. They accumulated many experiences in the treatment of bruises, snakebites, rheumatism, malaria, miasma, etc.

However, rapid socioeconomic development is currently leading to loss of indigenous knowledge on the uses of medicinal plants in this area [16]. The Li people do not have written literatures, consequently, traditional knowledge is transferred orally from one generation to the next thereby increasing deformation and the risk of extinction [15]. Moreover, there is little information in the literature on Li medicines and its relationship with the traditional culture of the Li people. Therefore, it is imperative to document and study Li medicines in order to conserve traditional herbal knowledge. The objective of this paper is to document traditional knowledge on the use of medicinal plants by the Li people and to discuss relevant factors accounting for a decrease in the use of Li medicinal plants.

Material and methods

Study sites

We conducted field work in three villages (Zha-zao, Fu-bao, and Jia-xi), which are located in Ledong Li Autonomous County, southwest of Hainan Province between N 18°24'–18°58' and E 108°39'–109°24' (Fig. 1). Ledong County covers an area of 2747 km² and occupies about 8.3% of Hainan's total territory. The study area is characterized by abundant rainfalls (1500–2000 mm yearly) and mild temperature (23–25°C per year) [17]. It is also rich in plant products, such as areca nut (*Areca catechu*), litchi (*Litchi chinensis*), longan (*Dimocarpus longan*), mango (*Mangifera indica*), cassava (*Manihot esculenta*), and passion fruit (*Passiflora edulis*). Ledong County has a population of about 500 000 inhabitants and Li ethnic group accounts for nearly 37% of the total population. In the three studied villages, the population is estimated at less than 3000 inhabitants, including 90% of Li people.

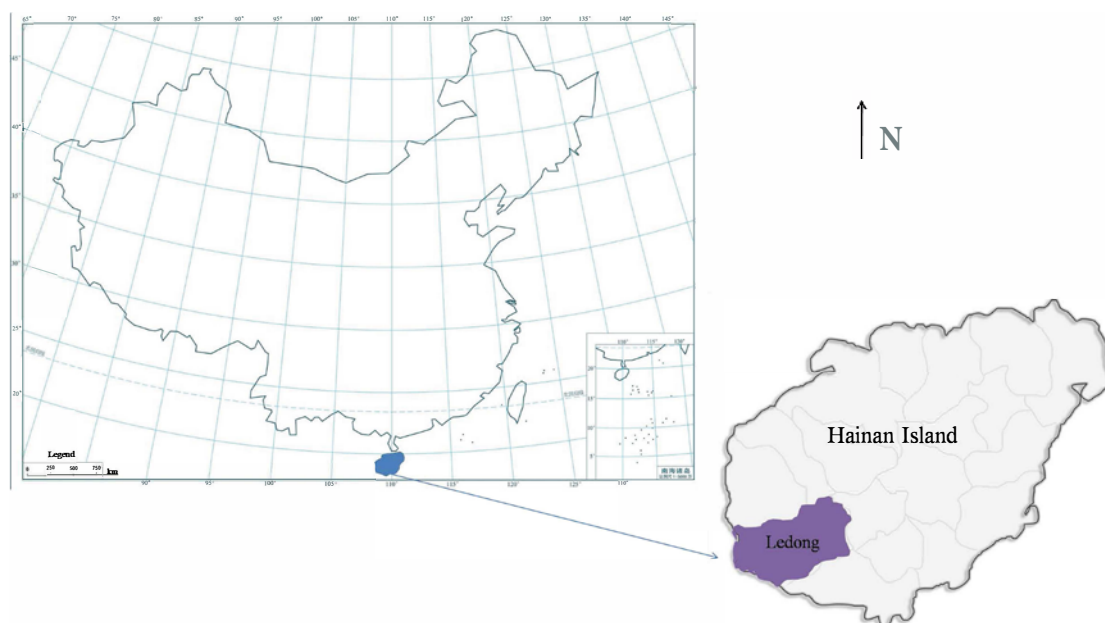


Fig. 1 The study area on the Hainan Island.

Data collection

The field works were carried out in three villages of Ledong Li Autonomous County from February to March 2012 and in July 2013. Data on medicinal plants used by the Li people were collected using the semi-structured interview approach [18], key informant interviews, participatory observations, and market surveys. Thirty knowledgeable people (elders or native herbal doctors) were chosen as key informants, with their ages ranging from 25 to 75 years. About 70% of the informants were more than 50 years old. To each respondent, questions were asked to assess their awareness about wild plants used in their area, local names of plants, parts used, mode of use, place of harvest, and habitats of each plant [19]. Voucher specimens of plants were collected in the field with the assistance of local residents. Plant species were identified by referring to Flora of China online and the Scientific Database of China Plant Species. The voucher specimens were deposited in the herbarium of Ethnobotany, Minzu University of China.

The mean proportion of commonly treated ailments, the parts of plants used and the methods of preparation of medicinal plants were evaluated using the cross-table analysis tool in Excel software. Recent existing literature on Li medicines were obtained by searching on SCI-Expanded (SCIE) and China National Knowledge Internet (CNKI) databases. Relevant data that could facilitate an analyses and comprehension of changes in the use of plants for Li medicines were collected by consulting literatures from the National Bureau of Statistics and processed in Excel software.

Results

Medicinal plants and their uses

A total of 50 medicinal plant species in 48 genera and 36 families were reported by Li people from the study area (Tab. 1). The three most represented families were that of Leguminosae (seven species accounting for 14%), Compositae, and Euphorbiaceae (comprised both of three species and accounting for 6% respectively). The most frequently used plant species were *Fordia cauliflora*, *Equisetum ramosissimum*, *Zanthoxylum nitidum*, and *Alpinia oxyphylla*. *Hedyotis ampliflora*, *Syzygium hainanense*, and *Libanotis seseloides* were equally used as wild fruits and wild vegetables, respectively.

Tab. 1 Plants species for medicinal purposes in Ledong County of Hainan Island.

Scientific name	Family	Local name	Ailments	Methods of preparation	Part used	Modern pharmacological activities	Voucher No.
<i>Adiantum capillus-veneris</i> L.	Adiantaceae		Oliguria, hepatitis	Decoction	Whole plant	Anti-inflammatory [46]	HN1201
<i>Alpinia japonica</i> (Thunb.) Miq.	Zingiberaceae	Duo gu	Pain, dyspepsia	Decoction, crushing	Root, fruit		HN1202
<i>Alpinia oxyphylla</i> Miq.	Zingiberaceae	Zi yen	Kidney ailments, common cold	Decoction	Fruit	Anti-angiogenic [47]	HN1203
<i>Amorpha fruticosa</i> L.	Leguminosae		Bleeding wounds, overheating, endogenous toxins	Decoction, macerated in alcohol, poultice	Flower		HN1204
<i>Andrographis paniculata</i> (Burm.f.) Nees	Acanthaceae	Me sai hao	Overheating, endogenous toxins, bronchitis	Decoction, crushing, poultice	Aerial part	Upper respiratory tract infectious diseases [48]	HN1205
<i>Antidesma bunius</i> (L.) Spreng.	Euphorbiaceae	Pa ban nong	Diarrhea	Decoction, crushing, poultice	Leaf, root		HN1206
<i>Antidesma montanum</i> Bl.	Euphorbiaceae		Pain	Decoction	Root, leaf, stem		HN1207
<i>Ardisia crenata</i> Sims	Myrsinaceae		Pain, rheumatism, lymphnoditis	Crushing, poultice	Root		HN1208
<i>Asparagus cochinchinensis</i> (Lour.) Merr.	Asparagaceae	Ze men len	Constipation, lungs diseases	Decoction, poultice	Root	Immune-related cutaneous diseases [49]	HN1209
<i>Bryophyllum pinnatum</i> (L. f.) Oken	Crassulaceae		Pain, edema, mammitis	Decoction, crushing, poultice	Whole plant	Anti-inflammatory [50]	HN1210
<i>Caesalpinia pulcherrima</i> (L.) Sw.	Leguminosae		Blood problems	Crushing, poultice	Seed	Antilucer [51]	HN1211
<i>Celosia argentea</i> L.	Amaranthaceae	Gan ba lan	Dizziness	Boiled in soup	Seed	Preventing urolithiasis [52]	HN1213
<i>Crotalaria pallida</i> Ait.	Leguminosae		Kidney deficiency, dizziness	Decoction	Seed		HN1214
<i>Datura stramonium</i> L.	Solanaceae		Convulsion	Decoction, macerated in alcohol	Leaf, flower, seed		HN1215
<i>Dianella ensifolia</i> (L.) DC.	Liliaceae	Gen wi ting	Abscess, tinea	Decoction	Rhizome		HN1216
<i>Dracaena angustifolia</i> (Medik.) Roxb.	Agavaceae	Pong hi	Gastroenteric disorder	Decoction	Young stem	Anti-inflammatory [53]	HN1217

Scientific name	Family	Local name	Ailments	Methods of preparation	Part used	Modern pharmacological activities	Voucher No.
<i>Eclipta prostrata</i> (L.) L.	Compositae		Hepatitis	Decoction, macerated in alcohol	Aerial part	Anti-inflammatory [54]	HN1218
<i>Equisetum ramosissimum</i> Desf.	Equisetaceae	Zu nang	Fractures	Decoction	Aerial part	Antioxidant [55]	HN1219
<i>Erigeron acer</i> L.	Compositae		Pain	Decoction, crushing, poultice	Whole plant		HN1220
<i>Eryngium foetidum</i> L.	Umbelliferae		Cough, dyspepsia, snakebite	Decoction, poultice	Whole plant	Antimicrobial [56]	HN1221
<i>Exbucklandia tonkinensis</i> (Lec.) H. T. Chang	Hamamelidaceae		Timber	Decoction, macerated in alcohol, poultice	Stem		HN1222
<i>Flemingia philippinensis</i> Merr. & Rolfe	Leguminosae		Mosquito bites, inflammation	Decoction	Seed	High bacterial inhibitory [57]	HN1223
<i>Fordia cauliflora</i> Hemsl.	Leguminosae	Zhi hlou van	Stomatitis	Poultice	Leaf		HN1224
<i>Hedyotis ampliflora</i> Hance	Rubiaceae	Mian la wa	Bleeding wounds, trauma	Decoction	Whole plant		HN1225
<i>Hedyotis costata</i> (Roxb.) Kurz	Rubiaceae	Tha wong	Trauma	Decoction, poultice	Leaf		HN1226
<i>Helicteres angustifolia</i> L.	Sterculiaceae	Pa bian	Snakebite	Decoction, crushing, poultice	Whole plant		HN1227
<i>Jasminum nervosum</i> Lour.	Oleaceae	Ra ri	Hypofunction	Decoction, crushing, poultice	Whole plant	Antioxidant [58]	HN1228
<i>Lantana camara</i> L.	Verbenaceae		Overheating, endogenous toxins, rheumatism	Boiled in soup, crushing, poultice	Whole plant	Antulcer [59]	HN1229
<i>Libanotis seseloides</i> (Fisch. & C.A. Mey. ex Turcz.) Turcz.	Umbelliferae	Gan hai kao	Overheating, endogenous toxins	Crushing	Leaf		HN1230
<i>Lycopodium japonicum</i> Thunb.	Lycopodiaceae		Blood diseases, irregular menstruation	Decoction, crushing, poultice	Whole plant		HN1231
<i>Melastoma candidum</i> D. Don	Melastomataceae		Edema, pain, bleeding wounds	Decoction	Root, leaf		HN1232
<i>Osbeckia opipara</i> C.Y. Wu & C. Chen	Melastomataceae		Woman diseases	Decoction	Root, fruit		HN1233

Tab. 1 Continued

Scientific name	Family	Local name	Ailments	Methods of preparation	Part used	Modern pharmacological activities	Voucher No.
<i>Ottelia acuminata</i> (Gagnep.) Dandy	Hydrocharitaceae		Overheating	Decoction	Root, leaf		HN1234
<i>Petrocosmea dubouxii</i> Craib	Gesneriaceae		Bleeding wounds, snakebite	Decoction, crushing	Whole plant		HN1235
<i>Piper sarmentosum</i> Roxb.	Piperaceae	Be fiang	Rheumatism, gastritis	Decoction, crushing	Root	Anti-inflammatory [60]	HN1236
<i>Plumbago zeylanica</i> L.	Plumbaginaceae	Hong ken	Rheumatism, sprains, pyogenic infections	Decoction, macerated in alcohol, poultice	Whole plant	Tumor cell suppressed [61]	HN1237
<i>Polygonum perfoliatum</i> L.	Polygonaceae	Gang fi fa	Cough	Decoction	Leaf		HN1238
<i>Polyalthia suberosa</i> (Roxb.) Thwaites	Annonaceae		Sprains, snakebite, overheating	Decoction, macerated in alcohol, crushing	Fruit, leaf, root, bark		HN1239
<i>Pothos chinensis</i> (Raf.) Merr.	Araceae		Extravasated blood	Crushing	Whole plant		HN1240
<i>Pteris cretica</i> L. var. <i>nervosa</i> (Thunb.) Ching & S.H. Wu	Pteridaceae	Lonly	Abdominal pain	Decoction	Whole plant		HN1241
<i>Rauwolfia verticillata</i> (Lour.) Baill.	Apocynaceae		Pain, hypertension	Decoction	Root		HN1242
<i>Salvia plebeia</i> R. Br.	Labiatae		Sprains, flu, lymphadenitis	Decoction, poultice	Whole plant	Anti-inflammatory [62]	HN1243
<i>Sapium baccatum</i> Roxb.	Euphorbiaceae		Edema, insecticide	Decoction	Bark	Antimicrobial [63]	HN1244
<i>Senna tora</i> (L.) Roxb.	Leguminosae		Inflammation, constipation, dizziness	Decoction, macerated in alcohol, poultice	Seed	Anthelmintic [64]	HN1212
<i>Strobilus asper</i> Lour.	Moraceae		Snakebite, constipation	Decoction	Root, bark	Anti-diabetic [65]	HN1245
<i>Syzygium hatnanense</i> Chang et Miao	Myrtaceae	Zi pu	Burn	Decoction, crushing	Fruits, bark		HN1246
<i>Tadehagi triquetrum</i> (L.) H. Ohashi	Leguminosae	Ko gai	Oliguria, sore-throat	Decoction, crushing	Whole plant		HN1247
<i>Tilia tuan</i> Szyszyl.	Tiliaceae		Rheumatism, pain, sprains	Decoction, macerated in alcohol	Root		HN1248
<i>Viscum coloratum</i> (Kom.) Nakai	Loranthaceae		Rheumatism, lumbago	Decoction	Aerial part	Inhibitory effects on the formation of osteoclast-like multinuclear cells [66]	HN1249

Scientific name	Family	Local name	Ailments	Methods of preparation	Part used	Modern pharmacological activities	Voucher No.
<i>Zanthoxylum nitidum</i> (Roxb.) DC.	Rutaceae	Wu za wu ma	Inflammation, bleeding wounds	Crushing	Leaf	Antiulcer [67]	HN1250

Tab. 1 Continued

We recorded about 18 human ailments that were treated using medicinal plants. These plants were primarily used to heal bleeding wounds (12.9%), to treat body pains (11.4%), gastrointestinal disorders (11.4%) and trauma (10%; Fig. 2). The most common bleeding wounds in the Li area were caused by scratches, chops, and snakebites. On the other hand, the most common gastrointestinal disorders were stomachache and constipation, meanwhile the forms of trauma recorded were sprains and fractures or contusions. Women diseases mainly included menstrual disorder, amenorrhea, and metrorrhagia. With respect to trauma, it could be linked to the surrounding mountainous and inconvenient traffic living environment. In addition, Li people do not sell herbs or collect them for other sellers, but rather use them to heal household, family and friend diseases.

Parts of plants used and mode of preparation

The main parts of plants which are widely used for medicinal purposes include the entire plant (32%), roots (26%), leaves (18%), and aerial parts (6%) according to Fig. 3. The entire plant was mostly used for the treatment of snakebite, rheumatism, and sprains, while the roots were mostly used for analgesia and detoxification.

In the present study, plants remedies were mainly prepared by decoction (84%), then by crushing (38%), poultice (34%) and maceration in alcohol (16%; Fig. 4). Decoction is a common way for local people to prepare medicines. It enables the main chemical compounds to dissolve easily after heating and makes it readily available to the body [20]. Most medicinal plant preparations were taken orally (88%), while 38% were administered for diseases such as wounds or skin infections. Dosages were given differently depending on the age of the patient and severity of the condition being treated.

Life form and origin of herbal species

The life forms of the identified species included trees, shrubs, herbs, and climbers. Shrubs and herbs accounted for 80% of all the plant species recorded. About 86% of all the species were widely distributed in China and easy to harvest. Only *Hedyotis ampliflora* was endemic to Hainan Island while *Ottelia acuminata* was endemic to China. Six species (10%) were cultivated species including *Andrographis paniculata*, *Bryophyllum pinnatum*, *Amorpha fruticosa*, *Caesalpinia pulcherrima*, *Celosia argentea*, and *Crotalaria pallida*. Cultivation of medicinal plants cannot only conserve the plant resources, but also make them available for harvesting and use.

Li people used to practice swidden agriculture, resulting in their lands being vulnerable to alien invasive plants [21]. Six medicinal plants used by Li people were alien species originating from different parts of the world, including *Celosia argentea*, *Bryophyllum pinnatum*, *Equisetum ramosissimum*, *Senna tora*, *Datura stramonium*, and *Lantana camara*.

Discussion

Comparative study of Li medicinal plants with previous reports

Among the 50 plant species used by Li people, 24 species (48%) were found to have never been documented in the ethnobotanical investigation of Li ethnic group of Hainan Island [22–24]. On the other hand, the 26 remaining species (52%) like *Andrographis paniculata*, *Dracaena angustifoli*, *Celosia argentea*, *Rauvolfia verticillata*, *Bryophyllum pinnatum*, *Equisetum ramosissimum*, *Antidesma montanum*, *Tadehagi triquetrum*, *Asparagus cochinchinensis*, and *Melastoma candidum* have been previously documented in the literature. Among the 26 documented species, the medicinal application methods of 17 species were similar meanwhile nine new application methods were recorded. According to previous studies [22–24], herbaceous species

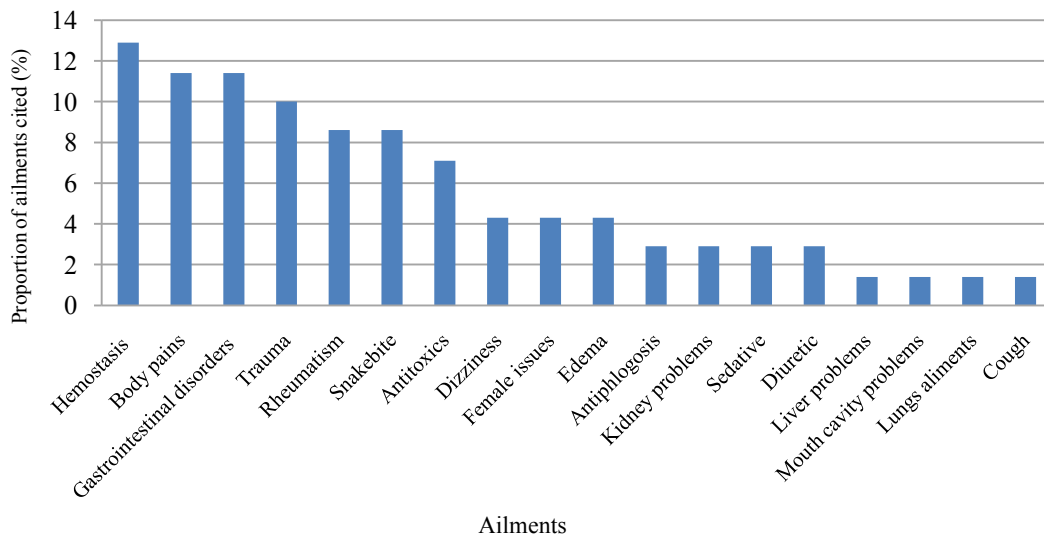


Fig. 2 Proportion of ailments treated with Li medicinal plants.

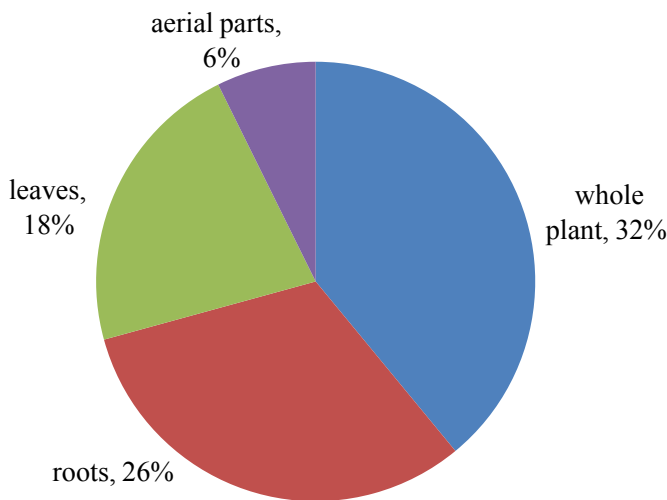


Fig. 3 Plant parts used for medicinal purposes and proportion of total medicinal species.

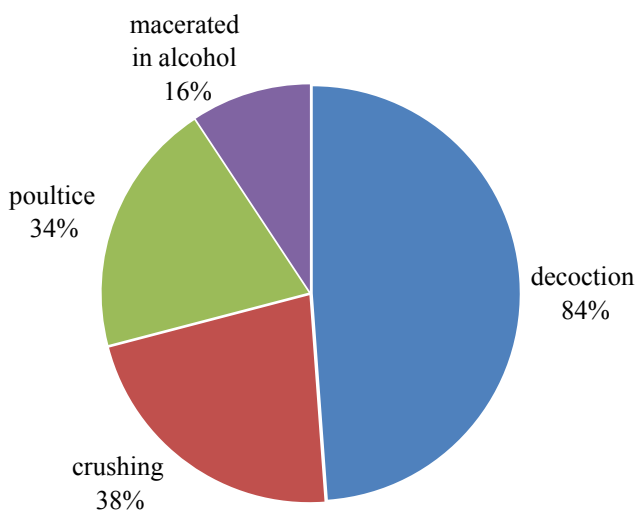


Fig. 4 Medicinal plants preparation methods.

were the most used among all plants recorded. Similarly, the most common utilized mode of treatment was by oral ingestion, and medicinal plants were primarily used to treat injuries, rheumatism, and infections. The characteristic diseases recorded in the study area were directly related to the mountainous, hot and humid environmental conditions of the area inhabited by the Li ethnic group.

Twenty-two species (44%) have been previously studied using modern research methods. These include *Bryophyllum pinnatum*, *Adiantum capillus-veneris*, *Piper sarmentosum*, *Caesalpinia pulcherrima*, *Streblus asper*, *Jasminum nervosum*, *Eryngium foetidum*, *Plumbago zeylanica*, *Senna tora*, and *Alpinia oxyphylla* (Tab. 1). The chemical compounds extracted from these plants were proven to be efficient bio-actives. They are important antioxidants, anti-inflammatory, antiulcer and anti-diabetic products. Among these 22 medicinal plants, the traditional medicinal functions of 10 species have been tested and confirmed by modern methods. These are *Andrographis paniculata*, *Adiantum capillus-veneris*, *Bryophyllum pinnatum*, *Sapium baccatum*, *Salvia plebeian*, *Senna tora*, *Piper sarmentosum*, *Plumbago zeylanica*, *Zanthoxylum nitidum*, and *Lantana camara*. Further pharmacological investigations will help to evaluate the traditional uses of local medicinal plants.

Possible factors accounting for a decrease in the use of Li medicinal plants

Loss of plant diversity. In the present study, only 50 traditional medicinal plant species were recorded in Ledong, the largest county of Hainan Province. This appears to be less than other ethnobotanical investigations conducted in the Li ethnic group [22–24]. Plant diversity in Ledong was compared with that of

Tab. 2 Comparison of medicinal plants between Ledong and other counties.

County	Acreage (km ²)	Population (10 ⁴)	Ethnic minorities	Climate	Family	Genus	Species
Ledong, Hainan	2763	50.0	Li	Tropical monsoons	36	48	50
Wuzhishan, Hainan	1128	46.5	Li	Tropical mountain	125	360	515
Jingxi, Guangxi	3322	65.0	Zhuang	Southern subtropical monsoon	67	104	116
Jinping, Yunnan	3677	35.6	Miao, Yao, Dai	Tropical monsoons	64	101	116
Wenshan, Yunnan	2977	48.9	Zhuang, Miao	Southern subtropical monsoon	92	**	220

** The data were not available.

some similar counties including Wuzhishan, Jingxi, Jinping and Wenshan (Tab. 2). The counties are located in the tropical areas of south China and have diverse ethnic minorities with small populations. They have a similar land area, climate, vegetation type, and population density [25]. Tab. 2 reveals that the number of medicinal plants recorded in Ledong is much less than that in the other four administrative zones. Despite its small surface area, Wuzhishan has the most abundant plant diversity of the province.

Change of land use. The decline in the use of medicinal plants by the Li ethnic group appears to be caused by the mode of land use. Referring to the *Hainan Statistical Yearbook* between the year 2008 and 2012 [26–31], we found that tropical crops planted per unit area in Ledong increased by about 8% against 4% in Wuzhishan (Fig. 5). The proportion of tropical crops on the total area of Ledong was much lower than that in Wuzhishan's before 2011. Afterwards, the former grew rapidly and was almost close

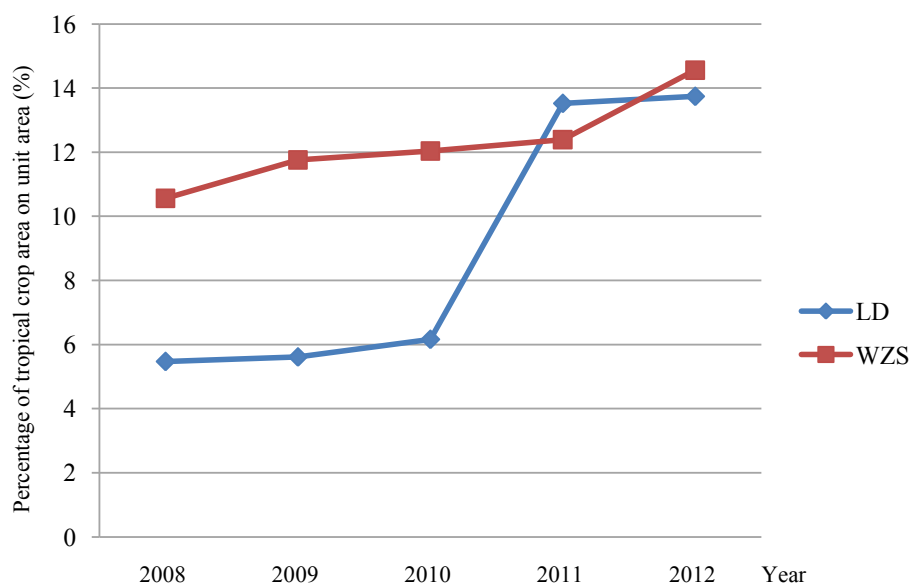


Fig. 5 Comparison of the proportion of tropical crops per unit area between Ledong (LD) and Wuzhishan (WZS) between the year 2008 and 2012.

to the latter. Despite that the Ledong County is more than twice as larger in size than the Wuzhishan County (Tab. 2), they possess almost the same proportion of tropical cropped area. However, the abundance in medicinal plants have become fewer in Ledong than in the Wuzhishan County. As a result of further comparative analysis of the two counties, the decrease in medicinal plants of Ledong appears to be caused not only by the expansion in surface areas planted with tropical crops but also because of the specific kinds of tropical crops cultivated (Fig. 6).

Among the tropical crops cultivated, there is increased cultivation of rubber trees, fruit trees, and vegetables. Comparisons between the three types of tropical crops in Ledong, Wuzhishan, and Jinping using the *Statistical Yearbook* from 2007 to 2012 (Fig. 6) [26–35], reveals that the output of each tropical crop in Ledong was much larger than that in the other two counties. Between 2007 and 2010, the dry rubber yield of Ledong was basically steady. However, there was a sudden increase between 2010 and 2011 in rubber production as well as for fruits and vegetables. With the rapid expansion of tropical crops, land available for medicinal plants is much reduced nowadays.

The intensive cultivation of tropical cash crop has resulted in a huge change of land use in most areas of Hainan Island. The tropical cash crops, such as rubber, cassava, eucalyptus, sugarcane, anti-season vegetables, and tropical fruits (coconut, banana, areca, pineapple, and papaya), have been cultivated widely nowadays. For example, there are about 491 000 km² rubber estate on Hainan Island [36], making Hainan the second largest natural rubber plantation base of China. The large-scale rubber estate was implanted at the cost of deforestation, which has led to the loss of natural habitat and traditional agricultural ecosystems. This large-scale destruction has accounted for the reduced abundance of local medicinal plants.

Threatened traditional knowledge. As the nomenclature and classification of medicinal plants is closely related to the Li's cultural diversity [37], it represents the wisdom and experience of medicinal plant resources used by the Li people. The traditional knowledge of Li medicines is orally transferred from generation to generation. More and more young people prefer to work in urban areas and offer less time to learn traditional medicinal knowledge. This is seriously affecting the transfer of cultural and traditional practices between generations and is a driving factor of acculturation.

From this study, it was observed that the old generation was more willing to use medicinal plants as primary health care. However, with the rapid expansion of tropical cash crops, local medicinal plants have decreased significantly. The elders cannot find herbs in the mountains as before. To this effect, there is limited use of herbs by the elders to treat their common diseases and consequently, they have to rely on modern health care [38]. The gradual reduction in Li medicinal plants, it is inevitably

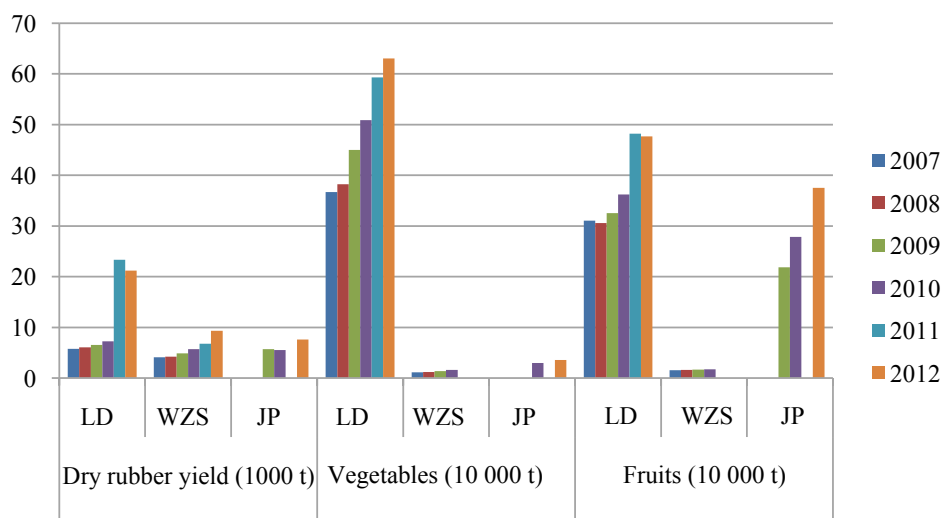


Fig. 6 The dynamic change of some main tropical crops in Ledong (LD), Wuzhishan (WZS), and Jinping (JP) from 2007 to 2012.

threatening their relevant traditional knowledge. For the young people living in urban areas which are far from the elders, the possibility to find or harvest medicinal plants is much difficult. Similarly, the vernacular names and culture of local plants will be forgotten, together with their uses and preparations methods. The impact of large-scale monospecific agro-industrialization is an important threat to traditional plants diversity and to the related traditional medicinal knowledge and culture.

To date, there are many uncertainties about the efficiency and importance of Li medicinal plants thereby making it difficult to be developed. Once its economic benefits and cultural values get accepted, its use and conservation will be greatly promoted [39]. According to traditional medical systems of Li ethnic group, the traditional uses can provide references for the development of modern therapies to some extent. For instance, some Li medicines have been studied and have shown good clinical efficacy, such as *Cephalotaxus hainanensis*, a good medicine for the treatment of leukemia; and *Calophyllum inophyllum* with anti-HIV ingredients [40]. To date, the drugs and products made from Li medicinal plants are still quite few [41]. Some species like *Alpinia oxyphylla*, known as one of the top four southern medicines (the other three are *Areca catechu*, *Amomum villosum*, *Morinda officinalis*), is now widely cultivated by farmers. Similarly, efficient medicinal plants such as *Fordia cauliflora* [42] and *Helicteres angustifolia* [43] can be taken into consideration for potential development of medicines. With the increased demand of herbal products in the international market [44], there is a possibility that the Li medicine will attract more interests.

In addition, the local government could take measures to conserve the culture and traditional medicines of the Li people by defining relevant policies for biodiversity conservation, promoting the consideration of the conservation of important biodiversity and community values by large-scale agro-industrialization projects, building cooperation with research institutions and corporations, encouraging young people to learn and cultivate medicinal plants, conducting training courses or workshops about the potential value of local medicinal plants [45], and facilitating propagandas about the culture of medicinal plants used by Li ethnic group.

Conclusion

Hainan is rich in biodiversity thanks to its favorable geographical conditions, which endows the Li medicine with distinct characteristics and compositions. However, only 50 medicinal plant species in 36 families were recorded in Ledong County. Compared to other regions, the number of medicinal plant species is lesser in Ledong County. Similarly, the plants are less abundant and available than in the past. The transfer of traditional knowledge between generations is disrupted. The increased plantation of cash crops especially rubber trees, vegetables and tropical fruits in Ledong is a driving factor for this trend meanwhile in other regions like Wuzhishan and Jinping, plantation of cash crops are stable and areas of rich plant resources are nearly untouched. This accounts for the low abundance of medicinal plants in Ledong. Therefore, it is clear that the monospecific cultivation of cash crops on a large-scale level may affect the local ecosystem structure. If the situation continuous, the related traditional knowledge of Li medicine will be further threatened. This case study addresses on a broader view, a scenario of the impact of rapid economic development in tropical China on the reduction of biodiversity and the associated traditional knowledge.

References

1. Cheung F. TCM: made in China. *Nature*. 2011;480(7378):S82–S83. <http://dx.doi.org/10.1038/480S82a>
2. Gesler WM. Therapeutic landscapes: medical issues in light of the new cultural geography. *Soc Sci Med*. 1992;34:735–746. [http://dx.doi.org/10.1016/0277-9536\(92\)90360-3](http://dx.doi.org/10.1016/0277-9536(92)90360-3)

3. Azaizeh H, Fulder S, Khalil K, Said O. Ethnomedicinal knowledge of local Arab practitioners in the Middle East region. *Fitoterapia*. 2003;74(1–2):98–108. [http://dx.doi.org/10.1016/S0367-326X\(02\)00285-X](http://dx.doi.org/10.1016/S0367-326X(02)00285-X)
4. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicine for drug discovery. *Environ Health Perspect*. 2001;109(1 suppl):69–75. <http://dx.doi.org/10.1289/ehp.01109s169>
5. Cordell GA, Colvard MD. Natural products and traditional medicine: turning on a paradigm. *J Nat Prod*. 2012;75(3):514–525. <http://dx.doi.org/10.1021/np200803m>
6. Ling C, Yue X, Ling C. Three advantages of using traditional Chinese medicine to prevent and treat tumor. *J Integr Med*. 2014;12(4):331–335. [http://dx.doi.org/10.1016/S2095-4964\(14\)60038-8](http://dx.doi.org/10.1016/S2095-4964(14)60038-8)
7. Li X, Xu X, Wang J, et al. A system-level investigation into the mechanisms of Chinese traditional medicine: compound Danshen formula for cardiovascular disease treatment. *PLoS One*. 2012;7(9):e43918. <http://dx.doi.org/10.1371/journal.pone.0043918>
8. Han SY, Li HX, Ma X, Zhang K, Ma ZZ, Jiang Y, et al. Evaluation of the anti-myocardial ischemia effect of individual and combined extracts of *Panax notoginseng* and *Carthamus tinctorius* in rats. *J Ethnopharmacol*. 2013;145:722–727. <http://dx.doi.org/10.1016/j.jep.2012.11.036>
9. Ding YF, Li F, Yang H. A brief exposition on study of different nationalities' traditional drugs of China. *Journal of Medicine and Pharmacy of Chinese Minorities*. 2001;7:20–22.
10. Wu X, Wang L, Wang H, Dai Y, Ye WC, Li YL. Steroidal saponins from *Paris polyphylla* var. *yunnanensis*. *Phytochemistry*. 2012;81:133–143. <http://dx.doi.org/10.1016/j.phytochem.2012.05.034>
11. Yin HX, Zhang H. Quality evaluation and germplasm survey of endangered ethnobotany of *Rhizoma paridis*. *Lishizhen Medicine and Materia Medica Research*. 2009;20:2863–2865.
12. Qiu PH, Xu SJ, Xie GZ, Tang BN, Bi H, Yu LS. Analysis of the ecological vulnerability of the western Hainan Island based on its landscape pattern and ecosystem sensitivity. *Acta Ecologica Sinica*. 2007;27:1257–1264. [http://dx.doi.org/10.1016/S1872-2032\(07\)60026-2](http://dx.doi.org/10.1016/S1872-2032(07)60026-2)
13. Long W, Yang X, Li D. Patterns of species diversity and soil nutrients along a chronosequence of vegetation recovery in Hainan Island, south China. *Ecol Res*. 2012;27(3):561–568. <http://dx.doi.org/10.1007/s11284-011-0923-3>
14. Yao HX, Chen XP, Lin L, Wu CM, Fu XJ, Wang H, et al. The spectrum of α - and β -thalassemia mutations of the Li people in Hainan Province of China. *Blood Cells Mol Dis*. 2014;53:16–20. <http://dx.doi.org/10.1016/j.bcmd.2014.01.003>
15. Guan YL, Pan Q, Huang MR. Ethnobotany and exploitation of medicinal plant resource in Hainan. *Journal of Nanjing Forestry University*. 2009;33:145–149.
16. Reyes-García V, Guèze M, Luz AC, Paneque-Gálvez J, Macía MJ, Orta-Martínez M, et al. Evidence of traditional knowledge loss among a contemporary indigenous society. *Evol Hum Behav*. 2013;34(4):249–257. <http://dx.doi.org/10.1016/j.evolhumbehav.2013.03.002>
17. Wang BS, Peng SL, Guo L, Ye YH. Diversity of tropical forest landscape types in Hainan Island, China. *Acta Ecologica Sinica*. 2007;27:1690–1695. [http://dx.doi.org/10.1016/S1872-2032\(07\)60040-7](http://dx.doi.org/10.1016/S1872-2032(07)60040-7)
18. Schmid CK. Ethnobotany: principles and applications. *Biodivers Conserv*. 1998;7(6):844–845. <http://dx.doi.org/10.1023/A:1008959420644>
19. Meilleur BA. Alluetain ethnobotany and traditional economy: the procurement and production of plant resources in the northern French Alps [PhD thesis]. St. Louis, MO: Washington University; 1986.
20. Song ZH, Ji ZN, Lo CK, Dong TT, Zhao KJ, Li OT, et al. Chemical and biological assessment of a traditional Chinese herbal decoction prepared from *Radix Astragali* and *Radix Angelicae Sinensis*: orthogonal array design to optimize the extraction of chemical constituents. *Planta Med*. 2004, 70(12):1222–1227. <http://dx.doi.org/10.1055/s-2004-835855>
21. Zhang RJ, Xing FW, Ng SC, Ye YS, Wang FG, Chen HQ. The alien plants and environment evaluation of Yinggeling Mountain, Hainan, China. *Ecology and Environment*. 2007;16(3):906–911.
22. Zheng XL, Xing FW. Ethnobotanical study on medicinal plants around Mt Yinggeling, Hainan Island, China. *J Ethnopharmacol*. 2009;124(2):197–210. <http://dx.doi.org/10.1016/j.jep.2009.04.042>

23. Zheng XL, Chen HF, Li RT, Xing FW. Medical ethnobotany of the Run dialect people of Li minority in Hainan. *Acta Botanica Yunnanica*. 2008;30:195–210.
24. Gan BC, Yang XQ, Li RT, He MJ, Du DL. Indigenous traditional medicine and utilization of plants by Li nationality. *Journal of Medicine and Pharmacy of Chinese Minorities*. 2006;2:24–26.
25. Long CL. Traditional management of natural resources in ethnic societies. Beijing: China Environmental Science Press; 2009.
26. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2007.
27. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2008.
28. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2009.
29. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2010.
30. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2011.
31. The Statistical Bureau of Hainan Province. Hainan statistical yearbook. Beijing: China Statistics Press; 2012.
32. The Statistical Bureau of Yunnan Province. Yunnan statistical yearbook. Beijing: China Statistics Press; 2009.
33. The Statistical Bureau of Yunnan Province. Yunnan statistical yearbook. Beijing: China Statistics Press; 2010.
34. The Statistical Bureau of Yunnan Province. Yunnan statistical yearbook. Beijing: China Statistics Press; 2011.
35. The Statistical Bureau of Yunnan Province. Yunnan statistical yearbook. Beijing: China Statistics Press; 2012.
36. Zhai DL, Cannon CH, Slik JW, Zhang CP, Dai ZC. Rubber and pulp plantations represent a double threat to Hainan's natural tropical forests. *J Environ Manage*. 2012;96(1):64–73. <http://dx.doi.org/10.1016/j.jenvman.2011.10.011>
37. Zheng XL, Xing FW. Preliminary study on folk medicinal plant nomenclature and classification of Li people in Hainan. *Journal of China Traditional Chinese Medicine Information*. 2010;2:68–70.
38. Mei WL, Chen P, Wang H, Huang JL, Dai HF. Two new sesquiterpenes from endophytic fungus S49 of *Cephalotaxus hainanensis*. *J Asian Nat Prod Res*. 2010;12(7):582–585. <http://dx.doi.org/10.1080/10286020.2010.485934>
39. Mohammed SA, Rana MJ, Jehan HA, Wafa AE, Fatemah AK, Kifayeh HQ, et al. Traditional knowledge of wild edible plants used in Palestine (northern West Bank): a comparative study. *J Ethnobiol Ethnomed*. 2007;4:13. <http://dx.doi.org/10.1186/1746-4269-4-13>
40. Spino C, Dodier M, Sotheeswarah S. Anti-HIV coumarins from *Calophyllum* seed oil. *Bioorg Med Chem Lett*. 1998;8(24):3475–3478. [http://dx.doi.org/10.1016/S0960-894X\(98\)00628-3](http://dx.doi.org/10.1016/S0960-894X(98)00628-3)
41. Verma S, Singh SP. Current and future status of herbal medicines. *Vet World*. 2008;1:347–350. <http://dx.doi.org/10.5455/vetworld.2008.347-350>
42. Liang ZY, Yang XS, Zhu HY, Hao XJ. Two new flavones from *Fordia cauliflora* of Yunnan. *Acta Pharmaceutica Sinica*. 2006;41(6):533–536.
43. Huang QF, Li YW, Zhang SJ, Huang RB, Zheng L, Wei L, et al. Effect and mechanism of methyl helicterate isolated from *Helicteres angustifolia* (Sterculiaceae) on hepatic fibrosis induced by carbon tetrachloride in rats. *J Ethnopharmacol*. 2012;143:889–895. <http://dx.doi.org/10.1016/j.jep.2012.08.018>
44. Samy RP, Gopalakrishnakone P. Nature Precedings [Internet]. Current status of herbal medicines and their future perspectives. 2007 [cited 2016 Mar 22]. Available from: <http://precedings.nature.com/documents/1176/version/1>
45. Long CL, Li SM, Long B, Shi YN, Liu BX. Medicinal plants used by the Yi ethnic group: a case study in central Yunnan. *J Ethnobiol Ethnomed*. 2009;5:13. <http://dx.doi.org/10.1186/1746-4269-5-13>
46. Haider S, Nazreen S, Alam MM, Gupta A, Hamid H, Alam MS. Anti-inflammatory and anti-nociceptive activities of ethanolic extract and its various fractions from

- Adiantum capillus-veneris* Linn. J Ethnopharmacol. 2011;138(3):741–747. <http://dx.doi.org/10.1016/j.jep.2011.10.012>
47. He ZH, Ge W, Yue GG, Lau CB, He MF, But PP. Anti-angiogenic effects of the fruit of *Alpinia oxyphylla*. J Ethnopharmacol. 2010;132(2):443–449. <http://dx.doi.org/10.1016/j.jep.2010.08.024>
 48. Panossian A, Wikman G. Efficacy of *Andrographis paniculata* in upper respiratory tract infectious diseases and the mechanism of action. Evidence and Rational Based Research on Chinese Drugs. 2013;137–179. http://dx.doi.org/10.1007/978-3-7091-0442-2_4
 49. Lee DY, Choo BK, Yoon T, Chenon MS, Lee HW, Lee AY, et al. Anti-inflammatory effects of *Asparagus cochinchinensis* extract in acute and chronic cutaneous inflammation. J Ethnopharmacol. 2009;121(1):28–34. <http://dx.doi.org/10.1016/j.jep.2008.07.006>
 50. Afzal M, Gupta G, Kazmi I, Rahman M, Afzal O, Alam J, et al. Anti-inflammatory and analgesic potential of a novel steroidal derivative from *Bryophyllum pinnatum*. Fitoterapia. 2012;83(5):853–858. <http://dx.doi.org/10.1016/j.fitote.2012.03.013>
 51. Wang Y, Curtis MJ, Yuk HJ, Kim DW, Tan XF, Park KH. Bacterial neuraminidase inhibitory effects of prenylated isoflavones from roots of *Flemingia philippinensis*. Bioorg Med Chem. 2013;12(21):6398–6404. <http://dx.doi.org/10.1016/j.bmc.2013.08.049>
 52. Kachchhi NR, Parmar RK, Tirgar PR, Desai TR, Bhalodia PN. Evaluation of the antiuroli-thiatic activity of methanolic extract of *Celosia argentea* roots in rats. International Journal of Phytopharmacology. 2012;3(3):249–255.
 53. Huang HC, Lin MK, Hwang SY, Hwang TL, Kuo YH, Chang CI, et al. Two anti-inflammatory steroidal saponins from *Dracaena angustifolia* Roxb. Molecules. 2013;18(8):8752–8763. <http://dx.doi.org/10.3390/molecules18088752>
 54. Tewtrakul S, Subhadhirasakul S, Tansakul P, Cheenpracha S, Karalai C. Antiinflammatory constituents from *Eclipta prostrata* using RAW264.7 macrophage cells. Phytother Res. 2011;25(9):1313–1316. <http://dx.doi.org/10.1002/ptr.3383>
 55. Paulsamy S, Moorthy D, Nandakumar K, Saradha M. Evaluation of in vitro antioxidant potential of methanolic extracts of the ferns, *Actiniopteris radiata* (Sw) Link. and *Equisetum ramosissimum* Desf. Int J Res Dev Pharm L Sci. 2013;2(3):451–455.
 56. Rojas-Silva P, Graziore R, Vesely B, Poulev A, Mbeunkui F, Grace MH, et al. Leishmanicidal activity of a daucane sesquiterpene isolated from *Eryngium foetidum*. Pharm Biol. 2014;52(3):398–401. <http://dx.doi.org/10.3109/13880209.2013.837077>
 57. Takawale H, Mute V, Awari D, Hukkeri VI, Mehta P, Vawhal P. Screening of antiulcer activity of *Caesalpinia pulcherrima* L. Bark. against aspirin induced ulcer in rats. World Journal of Medical Sciences. 2011;6(4):168–172.
 58. Huo LN, Lu RM, Li PY, Chen R, Deng CC, Lu CS, et al. Antioxidant activity, total phenolic, and total flavonoid of extracts from the stems of *Jasminum nervosum* Lour. Grasas y Aceites. 2011;62(2):149–154. <http://dx.doi.org/10.3989/gya.066810>
 59. Sathish R, Vyawahare B, Natarajah K. Antiulcerogenic activity of *Lantana camara* leaves on gastric and duodenal ulcers in experimental rats. J Ethnopharmacol. 2011;134(1):195–197. <http://dx.doi.org/10.1016/j.jep.2010.11.049>
 60. Zakaria ZA, Patahuddin H, Mohamad AS, Israf DA, Sulaiman MR. In vivo anti-nociceptive and anti-inflammatory activities of the aqueous extract of the leaves of *Piper sarmentosum*. J Ethnopharmacol. 2010;128(1):42–48. <http://dx.doi.org/10.1016/j.jep.2009.12.021>
 61. Lin LC, Yang LL, Chou CJ. Cytotoxic naphthoquinones and plumbagic acid glucosides from *Plumbago zeylanica*. Phytochemistry. 2003;62(4):619–622. [http://dx.doi.org/10.1016/S0031-9422\(02\)00519-8](http://dx.doi.org/10.1016/S0031-9422(02)00519-8)
 62. Peng MM, Fang Y, Hu W, Huang Q. The pharmacological activities of compound *Salvia plebeia* Granules on treating urinary tract infection. J Ethnopharmacol. 2010;129(1):59–63. <http://dx.doi.org/10.1016/j.jep.2010.02.029>
 63. Ahmed Y, Sohrab MH, Al-Reza SM, Tareq FS, Hasan CM, Sattar MA. Antimicrobial and cytotoxic constituents from leaves of *Sapium baccatum*. Food Chem Toxicol. 2010;48(2):549–552. <http://dx.doi.org/10.1016/j.fct.2009.11.030>
 64. Deore SL, Khadabadi SS, Kamdi KS, Ingle VP, Kawalkar NG, Sawarkar PS, et al. In vitro anthelmintic activity of *Cassia tora*. International Journal of ChemTech Research. 2009;1(2):177–179.
 65. Kumar RB, Kar B, Dolai N, Bala A, Haldar PK. Evaluation of antihyperglycemic and antioxidant properties of *Streblus asper* Lour against streptozotocin-induced diabetes in rats. Asian Pac J Trop Dis. 2012;2(2):139–143. [http://dx.doi.org/10.1016/S2222-1808\(12\)60032-2](http://dx.doi.org/10.1016/S2222-1808(12)60032-2)

66. Han N, Huang T, Wang YC, Yin J, Kadota S. Flavanone glycosides from *Viscum coloratum* and their inhibitory effects on osteoclast formation. *Chem Biodivers*. 2011;8(9):1682–1688. <http://dx.doi.org/10.1002/cbdv.201000289>
67. Bhattacharya S, Zaman MK. Ameliorative effect of *Zanthoxylum nitidum* root in chemical and stress induced gastric mucosal lesions in rats. *Middle East J Sci Res*. 2012;12(10):1349–1353.