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Aromatic lichen resources in Guizhou Province, China

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Abstract

Based on field investigation and references review, seven species of lichen were selected as aromatic resources. They are *Ramalina calicaris* var. *japonica* Hue, *Ramalia commixta* Ach., *R. fastigiata* Ach., *R. minuscula* Nyl., *R. sinensis* Jatta., *Alectoria sulcata* Nyl., and *Parmelina cirrhata* Fr. Their scientific name, Chinese name, distribution, vocher specimens, ethnobotanical uses, and their natural-product chemical constitutes distribution, potential deposits are described. Conclusion has been made that these species have great exploration and utilize value, while synthetic or semisynthetic ways are needed to protect the slow growing lichen resources.

Keywords: Aromatic lichens; Guizhou Province; potential resources; chemical constituents; protection

Introduction

So far, 2000-3000 species of aromatic plant resources have been discovered in the world, including lichens, mosses, ferns and higher plant [1], the abundant aromatic lichen resources have their unique value and have been used for a long history.

Lichens have been used as aromatic materials, which can trace to ancient Egypt, people in Sahara Desert collected *Parmelia andina* Müll. Arg. for tobacco flavors and fragrances at that time [2]. People in Europe use Oakmoss (*Evernia prunastri* (L.) Ach.) as a famous natural fragrance for its unique fragrant flavor ever since the 16th century. And lichens are used in many other Asian countries be ethnic groups [3,4].

As a result, the research of development and application of aromatic lichen, and the chemical constituents of its fragrant flavor have long been preserved in the world, the techniche such as HPLC, GC/MS [5-7], UV spectroscopic [8], DFT analysis [9], TLC(thin-layer chromatography) [10] and so on are widely used for extracting chemical components from lichen species[11-13], people discovered lichen have a certain flavor and the persistence of its fragrance, and it can mix with many other kinds of fragrances to form many kinds of odor types.

China harbors a rich lichen flora. Many species from 8 genera of 4 families can be used for producing lichen perfumery products based on the preliminary chemical analysis and evaluation [14]. Now, "Chinese tree moss" from *Ramalina fastigata*, "Chinese oakmoss No. 1" from *Evernia mesomorpha* and "Chinese oakmoss No.2" from *Cetrariastrum nepalensis*, etc. have been exploited and utilized in perfumery [14]. Guizhou Province are chosen as research site, field investigation and ethnobotany survey were made, seven species have been collected and selected as potential aromatic resources, two are also eaten by the local minority people, the other two have medicinal value. The present paper summarized the results of the investigation and survey.

Materials and Methods

The study site

The study area is Guizhou Province, which lies in the southwest part of the People's Republic of China. Its lichen flora is especially abundant due to its unique geographical location, completed topography, and climate diversity, it is estimated to have more than 70 species lichens in Guizhou [15].

Plant collections

The investigations were carried out in Guizhou Province between 2010 and 2012. The field study was preceded by a biographical study in which we established the list of lichen plants in the area. And then we went to Dasha River, Kuankuo River, Tree fern Nature Reserve, Xiliang Mountain, Yema Valley, Baili Rododenron Area, Qinglong Mountain, Yushe, Yaoren Mountain, Doupeng Moutain, Fanjing Mountain, Xiliang Mountain, together 8 area and 14 spots.

During the investigation, ethnobotanical data were collected through different interview methods (participatory rural appraisal (PRA), direct observation, semi-structured interviews, key informant interviews, individual discussions, focus group discussions and questionnaires) [16-18]. We ask local people for the local aromatic lichen species and other uses in the checklist we done before, and judge the candidate species by smelling the flavor.

Specimens were examined and identified by the authors and other taxonomists and will be deposited in the Herbarium of the Minzu University of China (Beijing).

Results

In the paper we present these seven species from three genera and two families as aromatic resources Table 1.

Discussion

Traditional collections of these aromatic lichens are done by villagers of various ethnic groups such as *Yi*, *Miao*, *Shui* and other ethnic groups for many uses including fragrant flavor, fodder, tobacco flavors, wild edible plant and medicine (Table 2).

Lichens widely used in biomonitoring studies of air pollution, either as bioindicators of air quality or as bioaccumulators of atmospheric deposition [22,23]. All seven selected species grow on tree trunks and branches at high altitude and have a huge biomass amount; they only grow well where there is no pollution, as a result, accompanied

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S/N	FAMILY	NAME OF PLANT	CHINESE NAME/PINYIN	DISTRIBUTION	VOCHER SPECIMENS
1	PARMELIACEAE	*Alectoria sulcata* Nyl.	沟树发/gou shu fa	China (Gansu, Shannxi, Sichuan, Yunnan, Taiwan); widely distributed all over the world.	Doupeng Mountain, 1560m; Yushe, 1600m; Xiliang Mountain, 2800m; Shuicheng, 2100m.
2	PARMELIACEAE	*Parmelina cirrhata* Fr.	扁条梅衣/bian tiao mei yi	China (Gansu, Shannxi, Sichuan, Xizang, Yunnan, Zhejiang, Anhui, Taiwan); Japan, North Korea, India, South America.	Leigong Mountain, 2060m; Xiliang Mountain, 2800m; Doupeng Mountain, 1200m.
3	RAMALINACEAE	*Ramalina calicaris* var. *japonica* Hue	杯树花日本变种/bei shu hua ri ben bian zhong	China (Jilin, Heilongjiang, Yunnan, Taiwan); Japan.	Doupeng Mountain, 1400m; Leigong Mountain, 1800m; Xiliang Mountain, 2750m; Shuicheng, 2100m.
4	RAMALINACEAE	*Ramalia commixta* Ach.	拟树花/ni shu hua	China (Jiangsu, Zhejiang); Japan.	Xiliang Mountain, 2800m; Kuankuoshui, 1500m.
5	RAMALINACEAE	*Ramalina fastigiata* Ach.	丛生树花/cong sheng shu hua	China (Hunan, Shandong, Shannxi, Yunnan); also in other countries in Asia, Europe and North America.	Doupeng Mountain, 1561m; Leigong Mountain, 1600m.
6	RAMALINACEAE	*Ramalina minuscula* Nyl.	裂树花/li shu hua	China (Shanxi, Shandong, Zhejiang, Fujian, Shanxi, Xinjiang, Taiwan); widely distributed in North Hemisphere.	Leigong Mountain, 1800m; Shuicheng, 2100m.
7	RAMALINACEAE	*Ramalina sinensis* Jatta.	扁条梅衣/ bian tiao mei yi	China (Shanxi, Shandong, Zhejiang, Fujian, Shanxi, Xinjiang, Taiwan); widely distributed in North Hemisphere.	Leigong Mountain, 1800m; Shuicheng, 2100m.

Table 1: List of investigated aromatic lichens in Guizhou.

S/N	FAMILY	NAME OF PLANT	CHEMICAL CONSTITUENTS	ETHNIC USES
1	PARMELIACEAE	*Alectoria sulcata* Nyl.	**Virensic acid** (10-formyl-3,9-dihydroxy-1,4,7-trimethyl-6-oxobenzo[b] [1,4] benzodioxepine- 2 -carboxylic acid) **Ethyl haematommate** (ethyl 2-(furan-2-carbonyl)-3-oxobutanoate) **Rhizoni acid** ($C_{10}H_{12}O_4$) **Haematommic acid** (3-Formyl-2,4-dihydroxy-6-methylbenzoic acid) [19]	Fragrant flavor; wild edible plant; fodder; medicinal, for strengthen kidney and enhance physical fitness, and curing dizziness.
2	PARMELIACEAE	*Parmelina cirrhata* Fr.	**Atranorin** (3-hydroxy-4-methoxycarbonyl-2,5-dimethylphenyl)3-formyl-2,4-dihydroxy-6-methylbenzoate) **Salazinic acid** (1,3-dihydro-1,4,10-trihydroxy-5-(hydroxymethyl)-8-methyl-3,7-dioxo-7H-isobenzofuro [4,5-b] [1,4] benzodioxepin-11-carbaldehyde) [20]	Fragrant flavor; medicinal, for curing metrorrhagia and metrostaxis, wounds and stop bleeding.
3	RAMALINACEAE	*Ramalina calicaris* var. *japonica* Hue	**Salazinic acid** (1,3-dihydro-1,4,10-trihydroxy-5-(hydroxymethyl)-8-methyl-3,7-dioxo-7H-isobenzofuro [4,5-b] [1,4] benzodioxepin-11-carbaldehyde) **Sekikaic acid** (2-[(3,4-dihydroxyphenyl)carbonyloxy]-4,6-dihydroxybenzoic acid) [20]	Fragrant flavor; wild vegetable; tobacco flavors.
4	RAMALINACEAE	*Ramalia commixta* Ach.	**Usnic acid** (2,6-Diacetyl-7,9-dihydroxy-8,9b-dimethyldibenzo [b,d] furan-1,3(2H,9bH)-dione) [20]	Fragrant flavor; tobacco flavors.
5	RAMALINACEAE	*Ramalina fastigiata* Ach.	**Usnic acid** (2,6-Diacetyl-7,9-dihydroxy-8,9b-dimethyldibenzo [b,d] furan-1,3(2H,9bH)-dione) [20]	Fragrant flavor; wild edible plant; tobacco flavors.
6	RAMALINACEAE	*Ramalina minuscula* Nyl.	**Usnic acid** (2,6-Diacetyl-7,9-dihydroxy-8,9b-dimethyldibenzo[b,d] furan-1,3(2H,9bH)-dione) **Divaicatic acid** ($C_{11}H_{14}O_4$) [20]	Fragrant flavor; tobacco flavors.
7	RAMALINACEAE	*Ramalina sinensis* Jatta.	**Usnic acid** (2,6-Diacetyl-7,9-dihydroxy-8,9b-dimethyldibenzo[b,d] furan-1,3(2H,9bH)-dione), divaicatic acid ($C_{11}H_{14}O_4$) [20,21]	Fragrant flavor; tobacco flavors; fodder.

Table 2: Chemical constituents and ethnic uses of aromatic lichens in Guizhou.

with the long history use of lichen by ethnic groups, local people also developed their traditional management of lichen resources. They get certain amount of aromatic lichen for self-use or commercial; they have an awareness of protecting lichen's habitat in the forest for sustainable use of lichen resources.

Chemical study explained the traditional knowledge of indigenous usage of aromatic lichens. *Alectoria sulcata* Nyl., and *Parmelina cirrhata* Fr. have medicinal values according to ethnobotany investigations, their secondary metabolites contain lichenic acids, it is proved by studies: some lichen species' lichenic acids have antifungal activity, they have potential use as antifungal agents [24]; and the extracts of lichen species such as *Alectoria sp.* are active against Gram-positive, acid-fast, and fungal microorganisms [25]. Especially for virensic acid and salazinic acid, they are examined to have activity against HIV-2 integrase and mammalian topoisomerase I of less than 100 μM [26].

All the 7 species traditional using as aromatic resources can also be explained by the new chemical studies, it is reported that the major fragrance of lichens come from the massive depsides and depsones after decarboxylation, hydrolysis and alcoholysis to get small molecular weight and aroma monoarylamine compound. Aromatic lichens has special aroma, their aroma last longer, and can be used as fixative and aromatizing agent, is a very important natural flavor extracts. All concretes of the seven selected species have strong aroma. Their yield of chemical concretes are ranged from 7.24%-9.68% [27], they have good prospect to be used as additive agent of cigarettes, and everyday chemicals products.

It is estimated the potential resources are about 30,000 tons in Guizhou Province [27], consequently, they have great potentials for making raw aromatic materials and they can easily to be put under mass production. With the Chinese government's environment protection policy, the biomass will increase accompanied with the restoration of forest vegetation. But the lichens are known to have a long lifespan and grow very slowly, if they are over-collected, the resources are really difficult to recover in the local environment and the ecological balance will be severely destroyed.

In future days, synthetic or semisynthetic ways are needed to exploit so as to protect the slow growing lichen resources.

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