Investigation and Utilization of *Ledum palustre L.* Resources in the North Temperate Zone

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Abstract. The field survey methods were used to investigate the species and distribution of wild *Ledum palustre ssp. decumbens* in the Daxinganling area. The results show that *Ledum palustre* L. is densely distributed in the Daxinganling area, distributed at high latitudes and high altitudes. It is widely distributed and a single species is concentrated. Daxing'anling area is rich in Duxiang resources, and has high economic value and medical value. The rational development and utilization of *Ledum palustre* L. resources can promote local economic development. *Ledum palustre* L. is a low-length, long-green shrub plant that is cold-tolerant, resistant to cockroaches, and resistant to inferiority. It is abundant in the Daxinganling region of China and is a resource-type plant. The extract of *Ledum palustre* L. contains bactericidal, Anti-inflammatory, anti-tumor and anti-oxidation components have certain development potential. Due to the different content of different components in different periods and different regions, and the immature extraction technology, it has not been developed and utilized so far. In this paper, the status quo of wild *Ledum palustre* L. is described in many aspects. The problems faced by *Ledum palustre* L. are also listed. The development prospect of *Ledum palustre* L. is analyzed reasonably.

1. Introduction

*Ledum palustre* L. is Rhododendron *Ledum palustre* L. and an evergreen shrub. The plant was high about 40cm. The leaves are rolled out. The brown hairs under the leaves are narrow strips, 1-3cm long, the flowers are white, the oval fruit, the seeds are small [1]. There are 10 species in the world, one species in China and one variant and one variant in China. They are concentrated in the Daxinganling Mountains, and there are also distributions in Xiaoxing'anling and Changbai Mountain. There are rich resources here. [2]. *Ledum palustre* L. contains triterpenoids such as ursolic acid, arbutin, dandelion sterol and coumarins such as quercetin, sulphate, and flavonoids. A compound such as quercetin, catechin, hyperoside, etc., which has pharmaceutical and aromatic value and is an important resource plant in the north temperate forest. *Ledum palustre* L. is a perennial shrub of the family Ericaceae. It is mostly born in Pinus sylvestris var. mongolica, larch forest, spruce forest or needle-broad mixed forest [3]. It is also common at altitudes of 400-1400 m. Hawthorn peat swamp or alpine meadow, produced in Daxing'anling and Xiaoxing'anling of Heilongjiang Province. *Ledum palustre* L. can extract aromatic oil, and the flower and fruit oil yield is higher [4]. In recent years, more and more literature reports on the extraction of aromatic oils from *Ledum palustre* L. into medicine, pharmacy, and industrial production have been reported [5]. However, the issue of *Ledum palustre* L. resources and effective development remains to be further studied.
2. The main value of *Ledum palustre L.*

2.1. Industrial development and utilization

In recent years, there have been more and more reports on the application of aromatic oils from *Ledum palustre L.* to medical, pharmaceutical, and industrial production, but the issue of *Ledum palustre L.* resources and effective development remains to be studied. *Ledum palustre L.* essential oils are used in the fragrance industry. In the country where *Ledum palustre L.* was grown in a large amount, the industrial development and utilization of *Ledum palustre L.* was mainly concentrated in tanning. As early as the 1940s, scholars in the Soviet Union have proved that there is a tannin component in *Ledum palustre L.* In the leafed part of the branch, therefore, *Ledum palustre L.* can be used as a raw material for enamel. Russia uses oil extracted from *Ledum palustre L.* to prepare oleaginous leather together with birch bark, giving it a unique odor [6]. This fragrance has not been marketed due to a strong pungent odor during the extraction process. Daxinganling is located between 121°12′ and 127°00′ east longitude and 50°10′ to 53°33′ north latitude. It is in the northernmost part of Heilongjiang River with an average elevation of 573 meters. It is a cold temperate continental monsoon climate, dry and windy in spring and warm in summer. Short, autumn is cool and comfortable, the winter is cold and long, the temperature difference between day and night is large, the annual average temperature is only -2.8℃, the lowest temperature is -52.3℃, the frost-free period is 80-110d, and the annual average precipitation is 746mm. The Daxinganling area is rich in forest resources, with a coverage rate of 79% and a total forest stock volume of 5.87×10⁸ m³. The plant community structure is simple and divided into four levels: trees, shrubs, herbs and ground cover.

2.2. Pharmacological development and utilization

2.2.1. Antibacterial anti-inflammatory. The volatile component of *Ledum palustre L.* can play an antibacterial and anti-inflammatory role. *Ledum palustre L.* has obvious effects and can effectively treat chronic bronchitis. The research literature shows that the amount of bacteria in the air is significantly reduced after *Ledum palustre L.* oil is freely evaporated in the air for 30 min. However, there is no significant change in the killing effect of bacteria in the air after different evaporation time, indicating the bactericidal ability of *Ledum palustre L.* oil. It has nothing to do with the length of time and is related to the concentration of *Ledum palustre L.* Studies have shown that *Ledum palustre L.* volatile oil inhibits and kills Staphylococcus aureus, Penicillium, and yeast. Penicillin is a kind of highly effective antibiotic, and its adverse reactions are serious. Moreover, in the process of taking antibiotics for a long time, the resistance of pathogenic microorganisms in the body is also increasing. Even if the dosage is increased, the therapeutic effect is not obvious. Possibility, when people are too dependent on this drug, it is crucial to find a drug that can replace this type of antibiotic. *Ledum palustre L.* oil contains factors that inhibit and kill yeast, penicillium, and staphylococcus aureus, so you can conduct in-depth research on volatile oil components and strive to replace penicillin antibiotics.

2.2.2. Suppress Anti-tumor efficacy. *Ledum palustre L.* contains ursolic acid, which inhibits the proliferation of tumor cells and is one of ursolic acid. Studies have shown that ursolic acid has obvious inhibitory effects on the growth of human erythroleukemia cell line, breast cancer cell line and lung cancer cell line, and has no obvious inhibitory effect on normal cells, indicating that *Ledum palustre L.* extract ursolic acid. The growth of malignant tumors has a significant inhibitory effect.

Cyclophosphamide is a relatively common anti-tumor drug, but it has genotoxic effects, and it has a high probability of causing sperm deformity, micronuclei formation of bone marrow polychromatic erythrocytes, chromosome aberration of bone marrow cells, etc. The substance is not genotoxic, and the *Ledum palustre L.* extract has broad prospects. In recent years, Chinese herbal extracts have become a hot spot as an anti-cancer auxiliary material treatment, and *Ledum palustre L.* hopes to become a new anti-cancer drug resource.
2.3. Cosmetic effect
Aging is the decline of an organism as it ages over its life cycle. Hydroxyproline is an important component of collagen, and skin aging is due to a decrease in synthetic collagen. *Ledum palustre* L. extract can be elevated in the concentration of hydroxyproline (L-HYP) and collagen in the skin of mice. Description: Oral *Ledum palustre* L. extract can make the skin tend to be younger and have anti-aging effects. *Ledum palustre* L. has strong antioxidant activity, and the clearance rate of $O^2\cdot$ and $\cdot$OH is as high as 88.42% and 86.35% at 0.05g/mL, and the scavenging effect is higher than the same concentration of mannitol. *Ledum palustre* L. has anti-aging effect and anti-oxidation effect. It can be used as a raw material for cosmetics and beauty products.

2.4. Ornamental value
With the rapid development of China's science and technology and social economy, forest tourism has become an emerging tourism industry. Wild flowers are particularly important in forest tourism. *Ledum palustre* L. mainly grows in the Daxinganling area of China, and the flowering period of *Ledum palustre* L. From June to July, the wild *Ledum palustre* L. forest is full of white flowers in the flowering season, adding infinite vitality to the forest. In 6.7 months, the northeast is also a perfect place for summer vacation, which is more conducive to the development of forest tourism. *Ledum palustre* L. can be planted in various parks and roads as green plants. The plants with small shape, light color and fine foliage can create a lively and bright atmosphere, which can not only play a green environment, but also purify the role of the air can also make people feel soothed.

3. Ecological Environment

3.1. The type of habitat diversity survey
*Ledum palustre* L. mainly grows in the forest under the swamp, and can survive in cold and dry areas. *Ledum palustre* L. is grown in an environment of 1000-1750m above sea level. It usually grows in river valleys or mossy swamps, and grows under the woods and in the waters of the water. It often grows in pieces. The ecological habits of *Ledum palustre* L. are the same as the original species. They are often born in river valleys or mossy swamps. They can also grow on wet hills or rocks. There are more cloths in the northwest part of Daxing'anling. Combined with the habitat and predecessor research of *Ledum palustre* L., it can be divided into the following grades according to the growth distribution of the species (Table 2): wet and cold habitat, warm habitat under the forest (sunrise), and undergrowth of the forest (shade), dry habitats, wet habitats. *Ledum palustre* L. is mainly distributed in the Daxinganling area in China. It is a single dominant population, and it grows under the forest. It is also found in swamps or high mountains with an altitude of 400-1400 m. If artificial harvesting is selected, the labor cost is too high. It is not suitable for large-scale machines because of its poor growth environment and inconvenient transportation. The best harvesting time is from July to September. It is best to process the leaves immediately after picking, so as to avoid the evaporation of oil, which undoubtedly increases the difficulty of harvesting.

3.2. Optimization of extraction process
At present, the common methods for extracting the active ingredients of *Ledum palustre* L. are steam distillation, solid phase microextraction, ultrasonic extraction, supercritical CO$_2$ extraction and other techniques are immature, and the extraction rate of *Ledum palustre* L. volatile oil has not been high. *Ledum palustre* L. The separation and purification techniques of physiologically active substances are used less, and the functional active ingredients cannot be quickly separated. At present, there are few studies on optimizing extraction and separation processes, and this problem is one of the problems that hinder the widespread application of *Ledum palustre* L. volatile oil.

3.3. Common associated plant survey
*Ledum palustre* L. has a lot of accompanying plants, and different accompanying plants form many
unique communities. Spruce, larch, white birch and camphor pine are the accompanying plants of large trees. The accompanying shrubs were mainly rhododendron sinensis, bilberry dux and cranberry. There are a large number of associated herbaceous plants, such as chamomile, burnet, willow orchid, mountain pea, forest wattle, sedge, etc. (table 1).

Table 1. *Ledum palustre* L. habitat type diversity

| Habitat type                        | Type (variant, variant)                |
|-------------------------------------|----------------------------------------|
| Wet, cold, ecological environment   | *Ledum palustre* L., Small leaf, *Ledum palustre* L. |
| Warm under the forest (sunrise)     | *Ledum palustre* L., Wide leaf, *Ledum palustre* L. |
| Under the forest, cloudy habitat (shade) | *Ledum palustre* L., Wide leaf, *Ledum palustre* L. |
| Dry habitats                        | *Ledum palustre* L., Small leaf, *Ledum palustre* L. |
| Moist habitats                      | *Ledum palustre* L., Wide leaf, *Ledum palustre* L., *Ledum palustre* L. |

Greater hinggan mountains region of *Ledum palustre* L. resources are abundant, but the active ingredients are limited, and only part of volatile oil can be used in processed *Ledum palustre* L., the component will produce large amounts of residue after extracting. *Ledum palustre* L. optimal harvest time was only about two months, due to the high quality and short time, the reasonable disposal of the leftovers is an urgent problem to be solved before the promotion of *Ledum palustre* L. If the surplus can be used as energy source to extract volatile oil in *Ledum palustre* L. then the disposal of the surplus can be solved and the production and processing cost can be reduced. However, whether it can be used effectively still needs to be further studied.

Table 2. Companion plants of *Ledum palustre* L.

| Level | Scientific name                        | Morphological characteristics | Adult plant height (m) |
|-------|----------------------------------------|------------------------------|------------------------|
| arbor | *Picea asperata* Mast.                | arbor                        | 45                     |
| arbor | *Larix gmelinii* (Rupr.) Kuzen.       | arbor                        | 35                     |
| arbor | *Betula platyphylla* Suk.              | arbor                        | 25                     |
| arbor | *Pinus sylvestris* var. mongolica Litv. | Evergreen trees             | 20                     |
| shrub | *Rhododendron dauricum* L.            | Semi-evergreen shrub         | 2.0                    |
| shrub | *Betula fruticosa* Pall.               | shrub                        | 1.5                    |
| shrub | *Spiraea thunbergii* Bl.               | Deciduous shrub              | 1.5                    |
| shrub | *Rosa davurica* Pall.                 | Upright shrub                | 1.5                    |
| shrub | *Vaccinium uliginosum* Linn.           | Deciduous shrub              | 0.8                    |
| shrub | *Vaccinium* spp.                      | Deciduous shrub              | 0.4                    |
| shrub | *Linnaeae borealis* Linn.             | Creeping evergreen shrub     | 0.1                    |
| Herbaceous | *Saussurea japonica* (Thunb.) DC.     | Biennial herb                | 1.0                    |
| Herbaceous | *Sanguisorba officinalis* L.        | Perennial herb               | 0.8                    |
| Herbaceous | *Eudolobium angustifolium* L.        | Stout perennial herbaceous   | 0.8                    |
| Herbaceous | *Vicia amoena* Fisch. ex DC.       | Perennial herb               | 0.6                    |
| Herbaceous | *Equisetum sylvaicum* L.              | Perennial herbs              | 0.4                    |
| Herbaceous | *Carex hirta* L.                     | Perennial herbs              | 0.3                    |
| Herbaceous | *Pyrola incarnata* Fisch. ex DC.     | Evergreen herbaceous         | 0.2                    |

4. Extract Development Prospect

The development of *Ledum palustre* L. in China is slow, because of the high cost of harvesting and the immature extraction process, *Ledum palustre* L. resources are not developed in a large area. Modern science and technology are developed, and *Ledum palustre* L. can be protected. At the same time, the wild *Ledum palustre* L. was introduced and domesticated to adapt to the environmental conditions of different regions and the domesticated *Ledum palustre* L. was widely used. It is also possible to introduce different varieties of *Ledum palustre* L. and *Ledum palustre* L. through modern science and technology in China, and to obtain more kinds of excellent *Ledum palustre* L., and try to apply to different types of land.
5. Conclusions
The volatile oil leather of *Ledum palustre* L. can be used in industry. In a large number of *Ledum palustre* L. growing countries, the use of *Ledum palustre* L. resources leather are effective. *Ledum palustre* L. can also be used as a spice, the harvest of *Ledum palustre* L. twig and leaf, essential oil by steam distillation, the heilongjiang province natural flavor evaluation fair appraisal, thought the dill aldehyde with special aroma, with sweet, is a good spice resources, can be used as a shampoo, soap, water and other products of raw materials. The special climate and geographical environment of the greater hinggan mountains are conducive to the growth and reproduction of *Ledum palustre* L. According to field investigation, the total storage capacity of *Ledum palustre* L. is about 6.6×10^9 kg. All the plants of *Ledum palustre* L. can extract aromatic oil. Branches: 0.17% to 1.50%. Flower: 2.30%. Results: 0.17%. The lowest oil yield (0.50%) was used to calculate the oil yield of 3.3×10^7 kg. The above figures belong to the theoretical ones, and there will be a big error between them and the actual ones. However, if the reserves are divided into half, the oil yield is 1.65×10^7 kg. If the rotation period is calculated every five years, 3.3×10^7 kg of aromatic oil can be used every year. *Ledum palustre* L. is a small perennial shrub, concentrated or dominant, so it is easy to harvest. Ursolic acid has anti-carcinogenic, anti-tumor angiogenesis, anti-cancer and anti-apoptosis effect of tumor cells. Ursolic acid is the most promising anti-tumor drug ingredient in the field of medicine at present, and it is expected to be a new anticancer drug. There are reports that *Ledum palustre* L. is the plant with the highest content of ursolic acid, which shows that *Ledum palustre* L. has a broad prospect for development.

Through on-the-spot investigation, found that the greater hinggan mountains region *Ledum palustre* L. resources, its hardy flood-resistant ability is strong, easy to harvest, such as widely used, still need to further study on its chemical composition. It can be combined with other drugs under reasonable conditions to achieve better therapeutic effects in clinical trials. Increased research on extracting volatile oil from *Ledum palustre* L. is important to boost both the cosmetic industry and the local economy, while protecting the ecological resources.

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