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“Ecology and resources of crude drugs”

## What I learned through overseas field research – Crude drug resources in China –

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As a country with few natural resources, Japan imports most of the crude drugs used in Kampo medicine, which is an important part of the current Japanese national medical system. However, little attention has been paid to the availability of crude drug resources overseas. The problem is that imports could suddenly be stopped or reduced due to changes in resource availability, politics, economics, climate, *etc.* Therefore, we need to pay more attention to this topic. In this article, the author reports on the availability and problems affecting the availability of crude drug resources using the experience he gained during overseas field research.

### Ephedrae Herba

According to the Japanese Pharmacopoeia, Ephedrae Herba is derived from *Ephedra sinica* Stapf, *E. intermedia* Schrenk & C.A. Meyer (Fig. 1), and *E. equisetina* Bunge. All of the crude drugs used are collected from wild plants because the alkaloid content of cultivated plants does not reach 0.7%, as demanded in the Japanese Pharmacopoeia. Through field research in the habitats of wild *Ephedra* plants in China, I have found that the most important reason for the reduction in *Ephedra* resources is the reclamation of land for farmland. Another factor is random exploitation and overgrazing by goats and sheep. *E. sinica* forms large communities in the wild, which are easily destroyed by tractors. This is not helped by the fact that its rhizome

is not a storage tissue and is not buried very deep in the soil. As a result of the abovementioned problems, large communities of *E. sinica* are now rarely found near to areas of human habitation.

Wild *Ephedra* plants are first pulled out by their roots, and then the aerial part is separated from the underground portion. Therefore, compared to *E. sinica*, whose rhizomes extend and reproduce more frequently than those of *E. intermedia*, *E. intermedia* tends to be affected more by such collection methods, resulting in its regional extinction. In addition, in hilly areas, where tractors cannot be used, besides individual collectors, villagers also form teams to collect *Ephedra* plants, which leads to the removal of entire *Ephedra* communities.

The reduction in *Ephedra* resources also is related to the effects of livestock. *Ephedra* plants bloom earlier than other plants in spring, so they are more likely to be eaten by livestock during this period. In recent years, the ratio of goats to sheep has risen to increase cashmere



Fig. 1 Wild habitat of *Ephedra intermedia* in Qinghai province.

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production. After being eaten by sheep, about 5 to 10 cm of the aerial part of the plant remains. However, goats eat the whole of the aerial part of the plant together with the root head, which causes more damage to the plant. *Ephedra* plants that have had the tips of their stems eaten are weakened and are not able to reproduce because this is where their seed cones bud.

Regarding its cultivation, *Ephedra sinica* is the only species cultivated at present because of the three original plants recorded in the Japanese Pharmacopoeia, *Ephedra sinica* has the most easily extendable rhizomes, allowing the number of plants to be increased within a few years of field planting. *E. equisetina* only grows on rocks and rubbly ground in the wild; therefore, this species is very difficult to cultivate. The seeds of *Ephedra* plants germinate pretty easily. Normally, after three years cultivation on a seedbed, the plants can be transplanted into a field. The aerial part of the plant can be harvested every autumn, and each plant can live for nearly 50 years.

Whereas the reclamation of the wild habitats of *Ephedra* species has led to their extinction in many areas, *Glycyrrhiza* plants facing the same problem can recover after farming has been abandoned. The reason for this is that the *Glycyrrhiza* rhizome is a storage tissue containing many starch grains and grows deep underground. Therefore, for the purpose of efficient resource utilization, different strategies should be adopted to preserving the plants used to produce each crude drug.

## Other crude drugs

Below is a brief outline of China's natural medicinal resources and the methods used to cultivate the plants from which the crude drugs used in Kampo medicine are produced. Like *Ephedrae Herba*, collection of the wild plant from which *Glycyrrhizae Radix* is derived (original plant: *Glycyrrhiza uralensis*) is now restricted in order to protect it and prevent desertification. Recently, *Glycyrrhizae Radix* produced from cultivated plants has gone on sale in crude drug markets. *Astragali Radix* has two cultivation varieties, Mian-Huang Qi (*Astragalus membranaceus*) and Jin Qi (*Hedysarum polybotrys*). The chance of seeing wild *Astragali Radix*

plants is even lower than the likelihood of encountering wild *Glycyrrhizae Radix*. *Bupleuri Radix* (*Bupleurum scorzonerifolium*) is mainly derived from cultivated plants because, even though its wild plants are not rare, they are distributed too sparsely to be collected. The wild variety of *Bupleurum scorzonerifolium* demonstrates great differences from the cultivated variety in the shape of its root and its external morphology. *Paeoniae Radix* (*Paeonia lactiflora*) has also mainly been derived from cultivated plants in recent years. This is because its wild plants normally grow in rubbly fields, which makes its collection hard work. The dried root is called Chi Shao, *Paeoniae Radix Rubra*, while boiled root from which the outer layers have been removed is called Bai Shao, *Paeoniae Radix Alba*. *Tribuli Fructus* (*Tribulus terrestris*) grows widely in arid terrain. One of the plants from which *Plantaginis Semen* is produced, *Plantago depressa*, is commonly seen in Northeast China. In the same region, *Clematis hexapetala*, a kind of Wei Ling Xian recorded in the Japanese Pharmacopoeia is also found on hills and grassland.

The wild plants used to produce *Polygalae Radix* (*Polygala tenuifolia*) and *Zizyphi Semen* (*Zizyphus jujuba*) are frequently seen in dry areas, and that used to produce *Saposhnikoviae Radix* (*Saposhnikovia divaricata*) often grows on dry steppes in Northeast China and Mongolia. The plant used to produce *Scutellariae Radix* (*Scutellaria baicalensis*) is largely cultivated (Fig. 2). Ningxia province is famous for the cultivation of *Lycii Fructus* (*Lycium barbarum*). *Aconitum carmichaeli*, from which crude drugs such as *Aconiti Tuber* are



**Fig. 2** Field used to cultivate *Scutellaria baicalensis* in Gansu province.

produced, is cultivated on the mountainside of Sichuan province. However, the quality of Aconite drugs varies according to the processing methods used; therefore, investigations should be conducted to standardize the quality of Aconite drugs.

Poria is cultivated in Hubei and Yunnan provinces. First, incubated hyphae are transplanted onto the dried cut pinewood, and the wood is buried in soil. Then, after around six months, the crude drug Poria can be collected. In Chinese market, there are currently no wild Poria and cultivated Poria dominate the market. *Atractylodes lanceae* Rhizoma (*Atractylodes lancea*) originates from both wild and cultivated plants grown in mountain terrain in Anhui province. The prevalent method for cultivating *Trichosanthis Radix* is by using a trellis. For *Gastrodia Tuber*, the symbiotic fungus is first inoculated into the cut wood of a broadleaf tree, and then the wood is buried in soil to allow the mycorrhizae to breed. Later, seeds of the original plant are sown into soil and cultivated in a field in shade.

In Sichuan province, *Magnoliae Cortex* is planted by the roadside or around fields while *Zanthoxyli Fructus* is cultivated in mountain areas. In the Xinjiang Uyghur Autonomous Region, *Carthami Flos* (*Carthamus tinctorius*) is widely cultivated. The author visited a *Rou Cong Rong* (*Cistanche deserticola*) cultivation area in Inner Mongolia this May, where the host plant *Haloxylon ammodendron* of the family *Chenopodiaceae* is planted. Around the roots of these plants, seeds of desert living *Cistanche* are sown for cultivation.

## Conclusion

During my research in Chinese markets, I was surprised to see many examples of different crude drugs sold under the same name. Most of them did not meet the standard of the Japanese Pharmacopoeia, but some are worth further investigation. Many of the crude drugs sold in medicinal markets underwent changes in their composition in the Qing dynasty. We need to perform detailed research in such markets as well as in wild habitats and cultivation fields to clarify the true origin and quality of crude drugs. Therefore, I hope that younger researchers will visit crude drug markets, especially in Asian countries (Fig. 3).

Although medicinal plants have recently been widely cultivated, many problems remain to be solved, such as the effects of agricultural chemicals. For the future of Kampo medicine, we need to understand the availability of crude drug resources in drug-producing countries and take measures to ensure the survival of important plants.



Fig. 3 Yu-Zhou Chinese Crude Drug Market in Henan province, one of 4 main crude drug markets in China.