

# Role and status of the botanical garden in the process of domestication of medicinal plants

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## Abstract

Medicinal plants resources are the basis for traditional Chinese medicine (TCM). *Ex situ* conservation and domestication are two essential measures to provide sufficient raw material for TCM with satisfactory quality. However, genetic erosion is very serious during the process of domestication of wild plants, which results in narrowing of the scope of heredity and the suppression of genetic diversity which is the foundation of breeding. As a preferred place of *ex situ* conservation, the botanic garden undertakes the important task of protecting germplasm resources and the genetic diversity. Therefore botanic gardens should be seen as a 'bridge' from nature reserve to breeding institutions. At the same time, government should encourage botanic gardens to collect native plants. Furthermore, botanic gardens are the most appropriate place to protect endangered medicinal plants and utilize cultivated medicinal plants.

## 1. The present situation of Chinese medicinal plant resources

According to a general survey of traditional Chinese medicine (TCM) resources from 1983 to 1988, there are 11,146 species of medicinal plants recorded in books and TCM dictionaries, among which over 700 species are commonly used in clinical practice. It can be deduced from the pharmacopoeia of the 2005 edition that the status of medicinal plants at least equals that of synthetic drugs and antibiotics in China. There are 2 volumes of the Pharmacopoeia of the 2005 edition, in the first volume of which the content is almost totally devoted to traditional Chinese natural medicines (consisting nearly exclusively of medicinal plants) and their varied preparation methods, with a total of 784 items, including natural medicines (without preparation methods) and medicinal plants; in second volume there are in total 967 items listed, including all the chemical medicines, antibiotic and biological drugs according to their preparations. It was proved by the statistics that the proportion of medicinal plants accounted for 40% of the whole market of TCM. There has been great development in Good Agriculture Practice (GAP) of traditional Chinese medicinal materials. By the end of 2003, the standardization of traditional Chinese medicinal materials established by the Ministry of Science and Technology encompassed 28 provinces, 73 items of medical materials and 195 bases. The majority of traditional Chinese medicinal materials, however, were prepared from wild resources.

Though there are relatively rich resources of medicinal plants in China, it is one of the countries where biodiversity has been destroyed the most severely. Medicinal plants accounted for a half of over 300 species of wild plants which were listed in the protection scope of our country. In the *China Plant Red book - Rare and Endangered Plants* published in 1992, there were 398 species of the endangered plants, including 168 species of medicinal plants, which amounted to over 42%. Generally, the quantities of medicinal plant resources decreased and could not meet medical needs, e.g. *Glycyrrhiza uralensis* Fisch., *Glycyrrhiza glabra* L.,

*Notopterygium incisum* Ting ex HTChang, *Vitex trifolia* L. var. *simplicifolia* Cham., *Phellodendron chinense* CK Schneid., *Boschniakia glabra* CA Mey., *Pinellia ternata* (Thunb.) Breit., *Ferula sinkiangensis* KM Shen and *Lithospermum erythrorhizon* Sieb. et Zucc., adding up to over 100 species. More than 30 kinds of medical materials including *Torreya jackii* Chun., *Antiaris toxicaria* Lesch., *Coptis omeiensis* (Chen) CYCheng, *Dysosma versipellis* (Hance) M.Cheng, *Magnolia officinalis* Cheng et Law, *Eucommia ulmoides* Oliv., *Berchemiella wilsonii* (Shneid) Nakai., *Panax ginseng*, *Dendrobium candidum* Wall. ex Lindl. were near extinction with scarce wild resources resulting in no supply or a small amount of commercial production of medicines. Besides, the wild plant of commonly used medicinal plants *Panax ginseng* and *Panax pseudo-ginseng* are difficult to locate. In the main producing area of *Panax pseudo-ginseng*, Yunnan province, not one wild plant has been found in the past few decades.

## **2. Domestication is the most effective measure to provide sufficient medicinal plant raw material**

Only if the wild medicinal plants are domesticated, can the dual goal to conserve and sustainably use medicinal plants resources be achieved. Two preconditions must be satisfied before the plants will be utilized in medicine and health. Firstly, efficiency. They can be referred to as medicinal plants, only when the cultivated medicinal plants contain enough effective components that have effect on illness. Secondly, the quantity of plant. A small quantity of the endangered medicinal plants even with a miraculous effect can meet the needs of a very small number of people, but cannot be made available to the public, especially the low-income masses.

At present, there is a total demand of about 4.3 million metric tons of medicines in China. But the total cultivation area of medicinal plants is about 300,000 hectares, and the gross output is about 1.2 million tons, which is less than half of the demand. Where the species are concerned, 70% of the commonly used medicinal plants species of the TCM raw materials still rely on wild resources. The consumed amount of many important species of medicinal plants exceeds the ability of the plant population to regenerate, which leads to a continuous drop of resources, and even the threat of extinction. For example, wild ginseng has been on the edge of extinction, but every year there is still a considerable number of varieties brought to the market.

Cultivation of medicinal plants is the fundamental way to solve the above problem. The most successful example is the solution used for medicinal raw materials of Ginkgo. The cultivation of Ginkgo with the aim of using its leaves was started in the mid-1990's in China; the production ability reached 10,000 tons in 1995, far beyond market needs. The GAP has developed tremendously in recent years. By 2003, there were 28 provinces, 73 varieties of herbal medicine and 195 total bases involved in the most important species of standardized Chinese herbal medicine established by the Ministry of Science and Technology.

## **3. Loss of genetic diversity caused by domestication of wild medicinal plants**

There still exist some problems during domestication; the relatively obvious one being that after a period of cultivation, the effective components in medicinal plants decrease, resistance and adaptability to the environment weakens, and damage by disease and insects becomes serious, therefore the usage of pesticides has to be increased. Because the use of pesticides cannot meet the demands of standard operating procedures, the techniques for the cultivation of medicinal plants is restricted. Cultivation of crops has encountered the

same problem, and the only solution was the adoption of improved varieties. Genetic diversity is the basis for breeding work. Only with good germplasm materials can breeders get fine breeding.

### 3.1. Loss of genetic diversity caused by domestication

The process of the domestication of wild plants leads unavoidably to the loss of genetic diversity. In the example of maize, there were more than 12,000 varieties for farmers to choose from 50 years ago, while the planted area of maize was less than a half of what it is currently. In Guangxi, there are 2,700 varieties of local maize germplasm resources, among which 1,217 local varieties have been conserved in national and Guangxi gene banks over a long period, which are all open pollinated varieties with a rich genetic basis. It is understood that a complex open system like that will have stronger ability to resist pests and natural disasters. In China, with the popularity of hybrids, the planted area of corn was enlarged to 23 million ha from 1980's to the mid-1990's, however, only 160 hybrids with narrow genetic range were popularized.

The threatened loss of genetic diversity has been greater for medicinal plants than for agricultural crops. Wild medicinal plant resources are excessively consumed which results in the abuse of wildlife resources and the damage to you the environment. Many valuable materials had disappeared before they were understood and studied. For example, in the 1970's, the effective component of wild ginger could be as high as 7% of the general content, with a maximum of 17%. However, with the abuse of the wild ginger resources, not only has its number reduced, but high level raw materials have decreased much faster. Now generally the accessible materials would only contain 2-3% of the effective component.

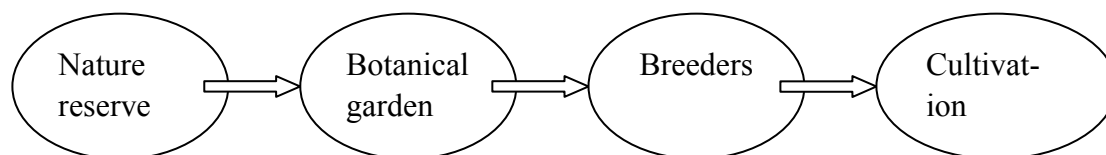
Conservation for medicinal plant germplasm resources is facing a dilemma, in which the domestication of wild plant will result in the loss of genetic diversity and the narrowing of genetic resources while utilization of wildlife resources will not only destroy the environment but speed up the loss of diversity.

### 3.2. Meeting the challenge of germplasm resource protection solved by *ex situ* conservation in botanic gardens

Germplasm resource conservation will be achieved by *ex situ* conservation. In other countries, units below species level have been paid more attention in the process of *ex situ* conservation, especially in the protection of the origin of seeds and genetic resources. As the first choice for *ex situ* conservation, the botanic garden has played an important role in the process of protection as well as development and utilization of germplasm resources. Many thousands of plants were introduced into botanic gardens of European countries and the United States from all over the world from the 19th century to the early 20th century. For example, every year thousands of packets filled with plants were shipped to the Royal Botanic Gardens, Kew, London during the 19th century. At the same time thousands of plants were also distributed to more than 100 colonial botanic gardens. Among these plants were important resources such as quinine, cocoa and rubber as industrial raw materials. The exploitation and utilization of these materials proves that botanic gardens have great importance to human life.

Terrestrial species have disappeared with amazing speed in modern society. Available genetic resources are being explored in unexploited regions by the countries all over the world. However, they fail to realize that a large number of rare species are conserved in their botanic gardens. A total amount of about 80,000 species, which accounts for 1/3 of the global plants species, are conserved in botanic gardens. Some species have high potential for development eg rubber, cocoa and *Cinchona*.

Botanic gardens have a role as a bridge between local protection (nature reserve), breeding research institutions and cultivation.



Botanic gardens are more familiar with morphological characteristics, habitats, cultivation and management of medicinal plants than most agricultural breeding research institutes. Botanic gardens in different regions, which are distributed in every district of the whole country, collect germplasm resources from native nature reserves, and the first transfer experiment is performed in the garden. The breeding materials are selected according to the performance of medicinal plants that are planted in a botanic garden by the agricultural breeding research institution; subsequently the improved varieties will be selected with conventional breeding or modern biotechnology techniques. Finally, it is the turn of the process of distribution and cultivation.

The above process is an overall process for medicinal plants changed from a wild variety to a domesticated one under ideal conditions. Botanic gardens undertake the tasks of basic breeding selection and experimentation with cultivation adaptability.

### **3.3 Botanic garden should pay attention to the preservation of local plant resources and help people to preserve these resources**

In *ex situ* conservation, the botanic garden should give preference to indigenous plants. With the development of biological technology and international exchange, the invasion of alien species occurs frequently, which severely threatens the original species and the environment. The government's forestry, agriculture and environment sectors should jointly set up a special fund to protect local species, and entrust the botanic garden to protect and study local plant species. When the species are introduced, the botanic garden should spread information about the protection of the ecology and biodiversity as well as giving technical guidance to local residents.

## **4. The cultivated medicinal plants in botanic gardens play an important role in social education**

According to the theory of TCM, there is a correlation between the effective component and the habitat of medical materials. Only the medical materials produced in specific areas have the best effect. However, this concept holds back the usage of transferred medicinal plants. There are some substitute medicines, which have the same curative effects as those of the original medicines, for instance, *Aquilaria agallocha*—*Aquilaria*

*sinensis* ; *Strychnos nux-vomica*—*Strychnos pierriana* ; *Ferula fukanensis*—*Ferula sinkiangensis*. Due to traditional concepts, however, the use of these substitute medical materials has not been widely accepted.

The botanic garden is an ideal place for popular science education which broadens knowledge about the replacement of wildlife resources with domesticated medicinal plants, thanks to the possession of many living botanical specimens. It is important to encourage the public to utilize cultivated medicinal plant material to ensure the sustainable use of wild medicinal plant resources.

## Further reading

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