

Gastrodia: An Initial Evaluation of the Market Potential of This Genus in New Zealand[©]

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INTRODUCTION

The genus *Gastrodia*, a member of the Orchidaceae family, includes over 30 species of terrestrial, deciduous, saprophytic plants native to Asia and the Western Pacific rim, from Japan through to Asia to India, and New Guinea, Australia, and New Zealand. In Asian medicine, *Gastrodia* (*Gastrodia elata* Blume) is highly regarded as a superior herb that can be taken for long periods to generally promote good health. *Gastrodia elata* grows throughout China and Korea, generally at altitudes above 300 m. Its large, tuberous, starchy rhizomes are used as a food and medicinal herb. Over the years, *G. elata* has been extensively harvested from the wild and is now an endangered species (He and Sheng, 1997). As a result, extensive research has been carried out to develop intensive cultivation techniques (Xu and Guo, 2000) and to a lesser extent to find substitute products (Dharmananda, 2002). New Zealand has three native species: *G. cunninghamii* Hook. f. and *G. minor* Petrie, which are endemic, and *G. sesamoides* R. Br., which is also found in Australia (Moore and Edgar, 1970). Of the three New Zealand species, *G. cunninghamii* is the most common and we have evaluated it as a possible substitute for *G. elata*.

BACKGROUND

***Gastrodia elata*.** The rhizomes of *G. elata* are a common ingredient in Chinese medicine (Bensky and Gamble, 1993). The main active ingredient is gastrodin, which has sedative, hypnotic, and antispasmodic properties and is used to treat migraines, epilepsy, spasms, convulsions, and dizziness (Bensky and Gamble, 1993; Dharmananda, 1991). Other major active ingredients include gastrodioside, vanillyl alcohol, *p*-hydroxybenzyl alcohol, vanillin, and *p*-hydroxybenzyl aldehyde (Wang et al., 2002).

Gastrodia elata has been used in traditional Chinese medicine (TCM) for at least 2000 years. It was originally called “chi qian”, meaning red arrow, because the plant has a red stem, shaped like the shaft of an arrow. Later it was called “tianma” or heavenly hemp.

Gastrodia is generally prepared for consumption by steaming or boiling. It is available as a thinly sliced, dried, raw product from Asian markets and also as an extract or powder. *Gastrodia* has been over-harvested in China as a result of the high value placed on this material. The resource has become increasingly scarce and is now listed under the Convention on International Trade in Endangered Species (CITES). To reduce pressure on wild populations, considerable effort has

been invested in attempts to cultivate *Gastrodia*. Initial attempts focused on the inoculation of wild populations of the host fungi, *Armillaria*. Although these trials enjoyed some success the results were unreliable and yields limited (Xu and Guo, 2000). The main problem was the low survival rate of germinating seedlings (Xu and Guo, 2000).

Life Cycle. A brown leafless flower stem emerges from the subterranean tuber in early spring and flowers are fully open from early to midsummer. The seed is shed from late summer to early autumn. By early winter the flower stem has died and there is little evidence of the plant's existence. To germinate, the seed requires the presence of the fungus *Mycena osmundicola* (Xu and Guo, 1989), although other *Mycena* species can also assist with germination (Fan et al., 1999a; 1999b; 2001). The *Mycena* fungi provide the germinating *Gastrodia* seedling with carbohydrates and other nutrients, although the nature of the relationship remains unclear (Xu and Guo, 2000). The plant does not photosynthesise at any stage during its life cycle so the germinating *Gastrodia* seedling must form a symbiotic relationship with the honey fungus, *Armillaria mellea*. Although a mature *Gastrodia* plant requires a symbiotic relationship with *Armillaria*, seed germination does not require the presence of *Armillaria*. The established seedling induces the *Armillaria* rhizomorphs to penetrate the orchid rhizomes. Fungal cytoplasm is then released into the cells of the orchid rhizome. *Gastrodia* does not produce chlorophyll so is totally reliant on this symbiotic relationship to survive. The plant overwinters as a dormant rhizome.

***Gastrodia cunninghamii*.** In New Zealand, *Gastrodia* is commonly called huper-ei, pere-i, maukuuku, black orchid, potato orchid, or sometimes the leafless orchid. *Gastrodia cunninghamii* has a similar life cycle to *G. elata*. The plant is long-lived and grows in dense clumps. The flower stems, which can grow up to 1 m tall, are the only above ground parts of the plant.

It lives in a mycorrhizal relationship with the New Zealand honey mushroom, *Armillaria novae-zealandiae* (Harris, 1997), which occurs in native forests and is also widespread in second-generation pine forests, kiwifruit orchards, and shelterbelts.

New Zealand Maori used the rhizomes of *Gastrodia* as a food, and regarded it as a delicacy as it was uncommon and hard to find (Crowe, 1981; Cooper and Cambie, 1991; Riley, 1994; Harris, 1997). Although *G. cunninghamii* is listed in the *Maori Healing and Herbal New Zealand Ethno Botanical Sourcebook* (Riley, 1994), no specific medicinal uses are mentioned.

NEW ZEALAND RESEARCH

Although the results of extensive research overseas have allowed many of the initial problems associated with propagating and growing *G. elata* to be overcome, work has also been carried out on the potential for the New Zealand species *G. cunninghamii*, for use as a market substitute. Analysis of the rhizomes using nuclear magnetic resonance spectroscopy (NMR) has shown that *G. cunninghamii* does not have appreciable concentrations of gastrodin, the main bioactive compound found in *G. elata*. However, this may be because the *G. cunninghamii* was not steamed prior to analysis. These studies also indicated that little or no vanillin was present in the *G. cunninghamii* rhizomes. Both *G. elata* and *G. cunninghamii* contain appreciable quantities of citrate esters. It is possible that gastrodin is released from these esters during steaming, prior to drying. Despite this, informal studies over

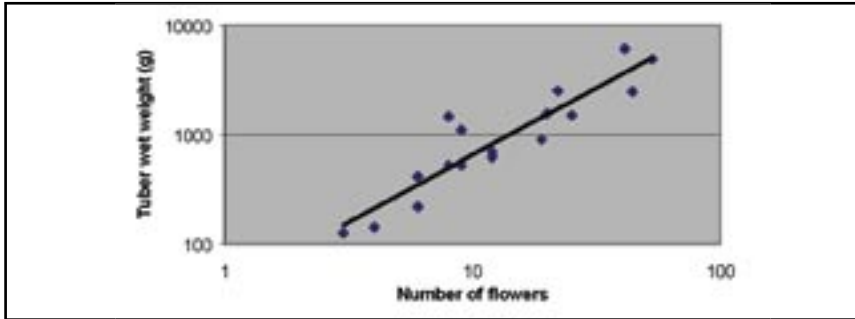


Figure 1: Relationship between *Gastrodia* flower stem numbers per clump and harvestable tuber wet weight

2 years (2001-02) have demonstrated some medicinal properties when *G. cunninghamii* is used as a substitute for *G. elata* in TCM, with TCM doctors and patients claiming *G. cunninghamii* could be used successfully for a number of medical conditions (J. Wong, pers. comm.).

The distribution of *G. cunninghamii* in New Zealand has been described as widespread (Moore and Edgar, 1970), but populations are always localised in its native environment. Our interest has stemmed from the widespread growth of *G. cunninghamii* in central North Island replanted pine forests in decaying pine slash, which favours the growth of *Armillaria*. Research has shown that gastrodia grows in clumps containing from one to many hundreds of rhizomes. One clump in the central North Island was found to contain nearly 400 rhizomes and had a total wet weight of 4.9 kg. As the only aboveground component of the plant is the flower stem, harvesting is easiest when the plant is flowering and while the senescing flower stem is still visible. Research suggests that a crop could be wild crafted with the number of flowers present being a good indication of the harvestable rhizome wet weight (Fig. 1). The relationship between the number of flower stems (x) and harvestable wet weight in grams (y) can be expressed as $y = 38.738x^{1.2264}$ ($R^2 = 0.85$).

The *Gastrodia* population observed growing in exotic pine forests is much larger than has been reported in indigenous forests. The pine slash left from previously harvested trees provides an excellent substrate for the *Armillaria* fungi. Under these circumstances, the expansion in the *Gastrodia* population is likely to be directly related to the vigour of the *Armillaria*: as the *Armillaria* declines so will the *Gastrodia*. The timing of this cycle is uncertain.

CONCLUSIONS

Gastrodia elata is a well-known and commonly used ingredient in TCM. Over-exploitation of wild populations has led to the plant being listed under the CITES agreement, which in turn has led to the development of intensive production in Asia and the evaluation of possible product substitutes. One such substitute is the New Zealand native *G. cunninghamii*. Initial studies indicate that the bioactive compounds differ between the two species, indicating that *G. cunninghamii* could not be used as a direct substitute for *G. elata*. Informal studies have indicated that *G. cunninghamii* has some bioactivity, but this needs further investigation.

These studies are preliminary and considerable work is required before *G. cunninghamii* could be recommended as a substitute in TCM. The *G. cunninghamii* observed growing in young pine plantations represents an untapped resource for wild-crafting, but the longer term sustainability of production is uncertain. If markets for the product were developed and harvesting from the pine forests proved unsustainable, intensive cultivation methods, like those in China used for *G. elata*, could be developed.

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