American Ginseng: An Overview on Medicinally Important Endangered Plant

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Abstract

American ginseng (*Panax quinquefolius* L.) is a herbaceous perennial plant belongs to the family Araliaceae found in deciduous forests of the United States from the mid-west to marine primarily in the Appalachian and Ozark region. It is an uncommon to rare plant of the eastern deciduous forest. It has a long history for medicinal use but it's over exploitation leads this plant to the verge of endangered species. Plant faces threat of extinction due to various factors including population growth, habitat destruction, exotic plants introduction and overexploitation among others. The rich resource is disappearing at an alarming rate as a result of over exploitation. Therefore the conservation of traditional medicinal plant resources has become a matter of urgency. This article trough's light on medicinally important plant American ginseng, its distribution, present status and means of conservation.

Key Words: American Ginseng, Conservation, Endangered, Medicinal plant

Introduction:

There is an expansion of the market of herbs and herbs based medicine all over the world. Medicinal plants have been the subjects of man's curiosity since time immemorial (Constable, 1990). Almost every civilization has a history of medicinal plant use (Ensminger et al., 1983). Approximately 80% of the people in the world's developing countries rely on traditional medicine for their primary health care and 85% of traditional medicine involves the use of plant extracts (Vieira and Skorupa, 1993). The over exploitation of medicinal plants leads to decrease in population of these species. Human activity is the primary cause of risk for 83% of endangered plant species. There are other factor such as anthropogenic pressure, introduction of foreign species as well as native striking special effects on plant diversity. As a result there is an increase in number of threatened species.

The conservation and maintenance of plant biodiversity is an important issue relating to the global human population.

In recent years, American ginseng (*Panax quinquefolius, L.*) has acquired a new niche in the international market. This herbaceous perennial has been traded for the last 5,000 years. So why the sudden interest? In Eastern cultures, this slow-growing plant is famous for its ability to assist the body in battling stress and disease. It is used to treat anemia, diabetes, gastritis and other conditions, including anti-aging. It's no wonder then that this medicinal plant should gain popularity in Western countries, particularly in the health food industry. The quandary of ginseng trade lies in current and perspective management and monitoring of ginseng exports. Due to the altering of habitat and introducing foreign plants to well-balanced ecosystems there has been a

decline of the plant species and its global population. Higher demand for the medicinal plant leads to increase conservation issues. If the plant is not properly regulated, there is a chance that ginseng could become extinct due to cultivation of the root before it reaches reproductive maturity and excessive collecting for export, mostly to Asian countries. This plant was included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975. The volume of root harvested annually prompted the Convention on International Trade in Endangered Species (CITES) to list *P. quinquefolius* on Appendix II (Robbins, 2000).

American ginseng is one of the most recognized ginseng botanical around the world (Ang Lee et al. 2001; Jia and Zhao, 2009). American ginseng is believed to provide an energy boost, lower blood sugar and cholesterol levels, reduce stress, promote relaxation, treat diabetes, and treat sexual dysfunction in men (Yun et al., 2001).In 1716, a Jesuit priest in Canada heard that Ginseng was extremely sought-after in China, so he searched for the herb in areas of French Canada environmentally similar to Manchuria. After three months of searching, he finally found a herb nearly identical to Asian ginseng near the city of Montreal - the herb he found became known as American Ginseng. American ginseng is native to deciduous forests of the United States from the mid-west to marine primarily in the Appalachian and Ozark region an edit is also cultivated in some places of China (Xiang, 2008). It is a perennial herb which belongs to the Araliaceae family (Punja, 2011).

It has long been used for medicines; originally harvested by many different Native American tribes and used in Asian medicinal products. Ginseng root is exported in larger volumes than any other native cites plant species. The majority of American ginseng harvested is exported to china. In the United States the harvest of wild American ginseng for international trade began in the mid-1700s. Today, the harvest continues to have strong economic and cultural importance to many communities in the United States and to American Indian tribes. There is preliminary, albeit circumstantial, evidence that harvest has led to a reduction in overall size of *P. quinque-folius* (McGraw, 2001). In herbarium specimens collected over the 20th century, nine of eleven size-related traits decreased significantly while age of specimen remained consistent (McGraw, 2001). Notably, this decline was most pronounced in specimens collected from Appalachian and southern states, areas that account for the largest portion of plants harvested annually (Robbins, 2000; McGraw, 2001). Like size reductions in other exploited species, the decline in stature of herbarium specimens of *P. quinquefolius* could be attributable to harvest if selective removal of larger individuals occurs.

Habitat loss through logging, agriculture, mountain top mining and development has rendered many areas unsuitable for American ginseng. In addition, overharvest and poor harvest practices (harvesting non-reproductive plants or those without ripe fruits) has led to a sharp decline in

existing populations. Furthermore, studies have found that browsing by white-tailed deer can have significant population impacts as deer often browse large, reproductive plants before they can produce seeds. Since American ginseng is slow-growing and produces few seeds, the loss of one reproductive plant before it has a chance to produce seeds can have large impacts on small populations of ginseng. Finally, the growing threat of invasive species within areas that support American ginseng is another problem.

Distribution:

American Ginseng was formally particularly widespread in the Appalachian and Ozark regions but due to the popularity and unique habitat requirements, the wild plant has been over harvested as well as lost through destruction of its habitat and is thus rare in most parts of U.S and Canada (Beattie-Moss, 2006). American ginseng is an inconspicuous herbaceous plant found in the understory of the Eastern deciduous forest. In fact, to the untrained eye, ginseng looks very similar to many leafy green perennials blanketing the forest floor. These plants experience a sheltered life, literally. Large trees shade the understory, absorbing sunlight and reducing evaporation from the soil surface. Herbaceous plants, like ginseng, may be particularly sensitive to changes in their stable environment.

American ginseng is grown in the eastern temperate forest areas of North America from southern Quebec, Minnesota and Wisconsin in the north to Oklahoma, the Ozorle plateau and Georgia in the south (Assinewe et al., 2003). With the wide spread popularity of herbal medicines in the west, the past few decades have witnessed some promising advances in research on American ginseng and its constituents (Li et al., 2010a; Sengupta et al. 2004; Wang and Yuan, 2008).

Structure:

The herbs consist of a light-colored, forked-shaped root, a relatively long stalk and green leaves with an oval shape. Its life cycle has two phases. Firstly seedlings have only 1 prong (leaf), which usually has 3 leaflets. The next phase has 2 prong plants with 3 or 5 leaflets on each mature plants have 2 or 4 prongs each with 5 leaflets (Fig 1. Taxonomical Classification and Photographs of A) Seeds, B) Leaves, C) Berry cluster and D) Roots of American ginseng.). Ginseng generally takes 3 to 8 years to reach sexual maturity. Sexually mature (or reproductive) plants will produce a single cluster of flowers, also known as an umbel, in early spring. The flowers on the outside of the umbel open first while those in the center of the umbel open last. The flowers can either be self-fertilized, or they can be cross pollinated with other plants. There are two known pollinators of ginseng: syrphid flies and halictid bees.

Typically, plants which are visited by pollinators have higher seed production. Following pollination, fertilized flowers will develop into green berries which later turn red at maturity. Each berry contains 1-3 seeds. The seeds will germinate after 18-20 months.

Ginseng also has a few evolutionary surprises. Ginseng's stem is actually found below ground. During the growing season,

this structure, known as a rhizome, develops a bud that will grow into the next year's visible ginseng plant. Rhizomes can also be used (along with seeds) to propagate plants (Van der voort et al., 2003) and in fact many old time ginseng harvesters used to plant the rhizomes at harvest to assure continuation of the population. The age requirement can have a negative effect of preventing one means of assuring continuation of the population. Since the rhizome produces a clone of the parent plant, this mode of reproduction helps to assure propagation of already-successful genotypes. Adventitious roots may form from these nodes in older plants (Van Der Voort et al., 2003).

Chemical Components:

The pharmacological properties of ginseng are mainly attributed to ginseng saponins, commonly called ginsenoisdes, the major and bioactive constituents (Ernst, 2010; Choi, 2008). With the development of modern chromatography, there are more 40 ginsenoisdes such as ginsenoisdes Rb1, Rb2, Rg1, Rd, and Re identified from ginseng up to date (Choi, 2008; Qi, 2011). Ginseng is one of the world's most important herbals used as an adaptogen and a cure for an impressively large range of ailments. Differences in the medicinal properties of ginseng roots have been attributed to variation in ginsenoside composition.

Ginsenosides share a dammarane-type triterpenoid saponin structure (Fuzzati, 2004). Most ginsenosides belong to a family of steroids with a four trans-ring rigid steroid skeleton (Attele et al., 1999; Wang et al., 2005). More than 60 ginsenosides have been isolated from different parts of *Panax quinquefolius* such as the roots, leaves, stems, flower buds and berries (Christensen, 2009; Jia and Zhao, 2009; Jiang et al., 2008; Nakamura et al., 2007; Qu et al., 2009; Yoshikawa et al., 1998). As chemical purification and structural identification techniques are developed, novel ginsenosides continue to be reported (Chen et al., 2009a; Jia et al., 2008; Li et al., 2009a; Nakamura et al., 2007). Differences in sugar types, quantities and attachment positions provide diversity in ginsenoside structures (Fuzzati, 2004; Jia and Zhao, 2009) (Fig 2. This figure shows the Ginsenosides characterized by American ginseng). The changeable C-20 side chain and stereoisomerism further enrich the structural diversity of ginsenosides (Christensen, 2009; Nakamura et al., 2007). A new ocotillol-type triterpenoid saponin, named 20(R)-pseudoginsenoside F (11) (1), was isolated along with pseudoginsenoside F (11) (2) from red American ginseng (Liu et al., 2012).

Ginsenoside isolated from *P. quinquefolius* can be divided into several groups protopanaxadiol (PPD) and protopanaxatriol (PPT) are two main groups of ginsenosides. In the PPD group sugar residues are attached to the b-OH at C-3 and/or C-20, whereas PDD include compounds 1-17 (Chen et al., 2009a). Four malony derivatives (18-21) also called as acidic ginsenosides have been characterized (Du et al., 2004).

Traditional Use:

P. quinquefolius has traditionally been administered as a tea for general tonic purposes and as an aphrodisiac. It has been used for thousands of years in the traditional

medical system in oriental countries (Ang-Lee et al., 2001; Attele et al., 1999; Wang and Yuan, 2008). It is used to dispel a cough and promote perspiration in colds, driving out the force of illness from within (Cellini & Philpott, 1990). *P. quinquefolius* has been traded interstate and overseas for hundreds of years, and it remains an integral part of the Appalachian economy (Cavender, 2003). The Iroquois Indians used ginseng for a variety of disorders including upset stomach, sore eyes and tape worm, but also as an article "to give thanks and for preventative health care" (Taylor, 2006).

Medicinal Importance:

American ginseng has been reported to have a wide range of pharmacological effects, including effects on the central nervous system, cardiovascular system, endocrine system, immune system and cancer (Court 2000; Jin et al., 2010; Li et al., 2010a; Yuan and Dey, 2001). Ginseng is an important herbal remedy extensively used to improve cardiac health and circulation. It had been used for centuries in treating an array of ailment and medical researchers have found that ginseng can be beneficial to the body in many ways. Treatment with ginseng has shown to improve cardiac performance. It also increases protection against myocardial ischemia/reperfusion damage by enhancing nitric oxide (NO) release (Masagatani and Grant, 1986). It has been believed that there may be substances in Ginseng that have anticancer properties (Yun et al., 2001). It may help men with erectile dysfunction. A 2002 Korean study revealed that 60 percent of men who took ginseng noticed an improvement in their symptoms (Dai-Ja et al., 2013).

Numerous studies indicate that *P. quinquefolius* reduces postprandial glycemia in diabetic and non-diabetic human subjects in doses as low as 1g, suggesting a possible role for this species in complementing existing diabetic treatment (Vuksan et al., 2000a; Vuksan et al, 2000b; Vuksan et al, 2001). In a recent *in vivo* anti diabetic screening study of ninety botanical species, all three *P. quinquefolius* products (rhizome, leaf, berry) tested positive for lipogenic activity (Babish et al., 2010). There has been a recent study which shows that American Ginseng regulates gene expression to protect against premature ovarian failure in rats (Lie et al., 2015). *In vitro* and *in vivo* anti colorectal cancer effects were ovulated by American ginseng berry extract and their representative bioactive compounds (Xie et al., 2009).

There are other studies which shows American ginseng to be effective in improving glycemic control in type 2 diabetes through increasing post-prandial insulin levels and decreasing post prandial glycemic response (Mucalo et al., 2012) and is safe in long term use in type 2 diabetes patients (Mucalo et al., 2014). In an interesting result it has been administered that ginseng extract has been involved in stimulated non-genomic eNOS activation, enhanced NO production and alleviated hypertension in SHRs (Hong, 2012).

Threatened Status:

Unfortunately, this wild perennial plant has become very rare in Canada, and the harvest of wild American ginseng is now considered unsustainable. Very few viable populations remain in Canada; even low levels of

harvest and poaching pose a real threat to its survival because of its slow growth and low rate of reproduction in the wild. American ginseng plants are long-lived but can take three to eight years to reach maturity and begin flowering. Researchers believe that the irregular cultivation of ginseng is caused by soil deterioration, pathogenic fungal accumulation, and allelochemicals in soil (Chen et al., 2006; Zhang et al., 2008; Lei et al., 2010a).

Ginseng is an herbaceous perennial that has been harvested for its valuable fleshy root since the early 1700s (Carlson, 1986). In regardless of the historical abundance of ginseng in some location, it has been reduced to populations of one to a few dozen individuals (Van Der Voort, 1998). Small populations are highly vulnerable to environmental stochasticity, natural catastrophes and to a lesser extent, demographic stochasticity (Menges, 1992). Most small populations revisited in Ontario in 1997, were declining (Nault et al., 1998). Harvest is a very common practice in Canada, especially in Ontario, where it affected 55% of surveyed sites. Nine populations were apparently lost due to harvest. The conservative life history strategy of ginseng explains its high sensitivity to harvest. Diggers collecting the largest plants found, remove the part of the colony that ensure population maintenance. It severely reduces the colony reproductive potential. Sutter in 1982 estimated that a collected population is producing the equivalent of 12-25% of seeds produced in a non-harvested population. According to Nantel et al., (1996), a 5% annual root harvest is sufficient to bring a viable ginseng population toward extirpation.

The major increase in harvesting rates, however, suggests that attitudes have changed. In North Carolina, diggers harvest everything they find before another digger can come and take the rest (Sutter, 1982).

Conservation:

Conservation Biologist often aim to sustain populations of endangered or threatened because they occur in small populations that are prone to extinction due to a variety of stochastic factors including environmental, genetic demographic and natural catastrophes. By understanding the deterministic elements that may affect the long term viability of population size. Results of Hackney and Mc.Graw 2001 suggest that it is unreasonable to assume that reproductive parameters will remain constant when populations are reduced by harvest with the inclusion of Allee effects. The detrimental effects of harvest on population viability may be greater than would normally be projected. Harvest is presently a nearby ubiquitous part of the ginseng environment, the Allee effect should be incorporated in simulations of the effect of harvest in natural populations in the con-text of population viability analysis. In addition, there may be opportunities to expand on the current American ginseng products by investigating niche opportunities that may include American 'red' ginseng or organically-grown ginseng in the future.

Today we have various scientific methods by which we can conserve or protect these endangered medicinal plant species. The

public is unaware about the current extinction crisis. Public awareness can be increased by education and social scientific program. Conservation education can be started from school level and may be enhance through camps or a journey to national and international parks/ Botanical gardens and museums. Research on ginseng pathogens and their management should be an on-going priority to avoid losses due to these diseases.

Biotechnology tools like plant tissue culture techniques and clonal propagation can be used under biotechnological approaches for conservation of endangered species. Nowadays micro propagation is very popular method which is used for commercial, economical, rapid propagation and ex-situ conservation of rare, endemic and endangered medicinal plants (Purohit et. al., 1994; Sudha et. al., 1996; Khan et. al., 2009; Tasheva, 2012).

There are recent research suggest all the known enzymes involved in the ginsenoside backbone biosynthesis and sequences involved in the latter stages ginsenoside biosynthesis pathway (Wu et al., 2013). Another study suggests the effect of boron nutrition on American ginseng growth in field (Proctor and Shelp, 2014). These studies can be helpful in improving the mechanism involved in faster growth of American ginseng.

Conclusion:

Many countries are dependent on the medicinal plants for health and well-being but increase in demand of medicinal plants has increased pressure on natural resource, which leads to overexploitation and degradation. Severe effects have been observed on those particularly which are harvested from wild. In order to combat this increasing demand initiative should be taken to protect local population and demand to natural resources. Medicinal plant conservation needs planning based on understanding of indigenous knowledge and practice. Studies on American ginseng are not extensive but there are many opportunities to better understand and utilize this species for its health-promoting properties. Further research on gene expression and regulation can be useful in understanding about the specific enzymes or proteins responsible for pharmacological activity of American ginseng.

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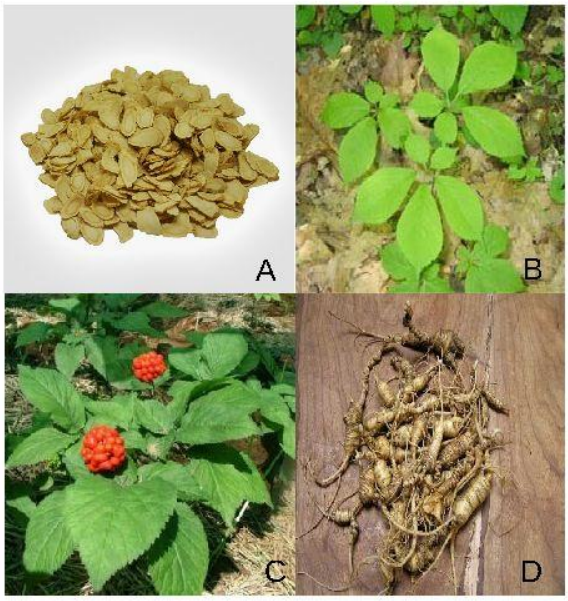
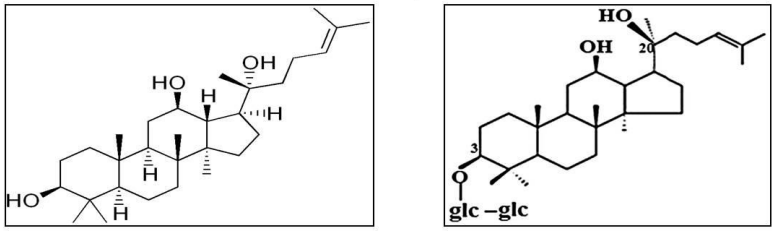


Scientific Classification:
Kingdom : Plantae
(Unranked): Angiosperms
(Unranked): Eudicots
(Unranked): Asterids
Order : Apiales
Family : Araliaceae
Subfamily : Aralioideae
Genus : Panax
Species : *P. quinquefolius*

Fig 1. Taxonomical Classification and Photographs of seeds, leaves, berry cluster and roots of American ginseng

Major Triterpenoids



Minor Triterpenoids