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Recent Studies of American Ginseng

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American ginseng (*Panax quinquefolium* L.) is one of the most widely used medicinal herbs in the world. It is indigenous to North America and was used by native North Americans long before the arrival of Europeans in the New World.[1,2] Ginseng cultivation in Canada has expanded rapidly in the last decade and has become one of the largest American ginseng producer in the world with annual production of 2.3 million kg. Approximately 90% of the product is exported to Orient. British Columbia produces approximately 40% of the total yield in Canada, and has become one of the major cash crops in the province.

Pacific Agri-Food Research Center of Agriculture and Agri-Food Canada has conducted ginseng research since 1993, range from crop management to chemical analysis and product development.

Rusty Root

The problem of rusty root has been identified as a major disorder for growers in every ginseng growing region in the world.[3] The potential damage to this industry is of great economical importance to all concerned, the average estimated damage is about 25% in some fields and can go up to 60% in some cases.[4,5]

The symptoms of rusty root on ginseng first appear anywhere on the root as small, raised, reddish rusty brown, and firm patches.[6] These rust-colored lesions are on the outer root layers, but larger lesions may penetrate deeper, and eventually disintegrate the whole root.[7] Seeds from affected plants may fail to germinate in the spring, or the foliage may turn yellow and wilt later in the season, especially in hot, dry weather.[6] This disease affects both seedlings and older plants.

There are two hypothesis about the cause for rusty root.[8] The fungi such as *Cylindrocarpon* and *Fusarium* species are often found associated with this disease[9,10] but systematic isolation and pathogenicity studies have not been done.[3] Other conditions such as alkaline soil or waterlogged soil may enhance the 'rusty' on the roots. The contents of NO_3, P_2O_5, and Ca were higher in the fields with more than 50% root rusting.[11] No systematic study has been done to determine if the cause of this disorder is boron or other micro-nutrient deficiency, but low boron may play a part in this condition.[5]

Another cause of rusty root is winter and/or spring injury. Ginseng roots may survive very cool temperatures. However, when the frozen ground thaws in warm weather, soil moisture increases dramatically due to melting snow and winter injury may occur if the temperature drops below zero again. In the spring, the buds start to grow when the ground temperature reaches 5°C. If the temperature suddenly drops below freezing during this time, the young buds may die or become injured. In some cases, the plants are still alive and may grow again next year (Li, personal observation). Winter injury can be prevented by covering the soil bed with straw in ginseng gardens. Healthy ginseng roots can tolerate winter damage better. In coarse sandy soil, temperatures fluctuate too much between day and night, which can also result in winter injury.

Seed stratification under controlled environments

Traditionally, in North America, seeds are harvested in late August or early September and stratified in a sand box buried outdoors.[12,13] Uncontrolled fluctuating temperature and moisture levels, and the presence of pathogenic organisms in the seed box, cause seeds to sprout prematurely, rot, dry out and die, or be delayed in germination by up to 2 years after seeding, with severely reduced germination rates.[14]

Stratifying seeds in a controlled environment is a potentially reliable method of reducing or eliminating these serious problems. In an indoor controlled environment, ginseng growers should be able to maintain a disease free environment and provide ideal temperatures and moisture

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levels for seeds to stratify as well as to monitor seed conditions. It was found that seed stratification carried out in a controlled environment indoors can shorten the length of the seed stratification period, increase percentage of germination, and avoid hazards experienced outdoors such as pathogens and fluctuation of temperature and moisture levels.[14]

Correlations between leaf and soil mineral concentrations and ginsenoside contents

There are many factors, including soil moisture level, fertility, texture, and pH, affecting the growth of ginseng. It was reported that that N, P, Ca, and Mg were the major elements affecting root weight.[15] Physiological stresses associated with differences in growth rate may also affect ginsenoside synthesis and accumulation.[16]

A study was conducted to determine the relationships between mineral levels in soil and leaves and ginsenoside contents in root and leaf of 4-yr-old American ginseng. It was found that soil nutrient levels were important in the accumulation of the biologically active ginsenosides in leaves and roots, and soils with slightly acidic pH and relatively high levels of Fe and S may produce ginseng with higher ginsenosides.[17]

Phytosterol content in American ginseng seed oil

Phytosterols are among the most important compounds in the unsaponifiables of vegetable oils and are implicated in conferring biological activities to the oils. Recently, their ability to reduce cholesterol in humans has been of particular interest.[18] Clinical studies have repeatedly shown that phytosterols taken as dietary supplements, or as supplemental ingredients in foods, reduced serum cholesterol and low-density lipid cholesterol levels in normal and mildly hypercholesteraemic subjects.[19]

Previous experiments have indicated that ginseng seeds are rich in oil[20] and that this oil may be useful as a specialty ingredient in functional foods or cosmetics because of its phytosterol content.[21] This study details the quantities and identities of phytosterols found in American ginseng seed oil.

A study was conducted to investigate phytosterol contents in ginseng oil extracted from stratified and non-stratified seeds.[22] The results of this study have educated farmers and the phytopharmceutical industry on the existing values of this easily accessed extra leftover ginseng seeds, and how to develop ginseng seed oil into a new product with its well documented medicinal values.

Product development by using waste material

There are two ways to de-pulp ginseng berries. Traditionally, berries were stored in a well misted burlap for a period of time and let the pulp to rot. More recently, de-pulp machine is used to obtain seeds and pulp is discarded.

Ginseng berry pulp, a waste material, contains ginsenosides, mainly Re, equivalent to 1-yr-old root, can be used as a source new products such as juice and powder for nutraceutical industry. It was reported that a major constituent, Re, from the ginseng berry shows real promise in treating diabetes and obesity.[23] It shows that the extract completely normalized blood glucose levels, improved sensitivity to insulin, lowered cholesterol levels, and decreased weight by reducing appetite and increasing activity levels in mice bred to develop diabetes. Additional studies demonstrated that ginsenoside Re plays a significant role in anthyperglycemic action. This antidiabetic effect of ginsenoside Re was not associated with body weight changes, suggesting that other constituents in the extract have distinct pharmacological mechanisms on energy metabolism.[23]

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