

Growing and Marketing Woodland Botanicals

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Medicinal herbs are increasing in popularity across the world. Consumer sales of herbs and botanicals reached \$4.41 billion in 2005 (Nutrition Business Journal 2006). Many medicinal herb products are made from native woodland botanicals that are wild-harvested from natural stands. Most, if not all, of these woodland botanicals can be cultivated commercially. This is beneficial for the conservation of native plant populations, good for farmers looking for new crops, and attractive to manufacturers looking for reliable sources of high quality material.

I have led a medicinal plant research and extension program for over 18 years, but in the last three years my staff and I have made a special effort to develop the North Carolina medicinal herb industry. We thought the time was right to do this for three reasons: (1) our state already has a reputation for being a source for high quality plants with exceptional potency; (2) we have growers who are ready and willing to grow herbs; and (3) the region is well suited for the development and expansion of the agricultural and processing sides of the industry.

My role in this effort is to conduct research on how to bring these native woodland botanicals into commercial production; determine the economics of production; explore the markets that are available; educate extension agents and growers; and raise awareness among the public, government, and non-profit sectors of our society about this industry.

Since 1989, we have conducted research on many native botanicals including goldenseal, bloodroot, black cohosh, and false unicorn. Here's a brief overview of each of these. All are herbaceous perennials, meaning the above ground parts of the plants die down each autumn and a new plant arises each spring from buds on the perennial underground rhizomes. A short review on our Medicinal Herbs for Commerce Project is also included.

BOTANICALS EVALUATED

Goldenseal

Goldenseal (*Hydrastis canadensis* L., Ranunculaceae) has special concerns. It is an endangered species in North Carolina; that makes collection from public lands illegal and puts special restrictions on cultivation of the plant. Goldenseal is a plant of concern throughout North America, and as a result, it is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This puts restrictions on international trade. These conservation measures are necessary because there is a high market demand for goldenseal. Thus, this is a good example of a native botanical that really needs to be cultivated.

Goldenseal has a bright yellow, horizontal rhizome covered with fibrous roots (Fig. 1). The plant spreads easily by these underground parts. The plant is about 46 cm tall with large, lobed leaves. Each plant puts on a single fruit which looks like a raspberry and is full of shiny black seeds. The plant can be propagated by seeds, but they have some exacting requirements for germination. Goldenseal is more commonly propagated by rhizome cuttings.

Although we do not yet know what gives goldenseal its medicinal properties, it is generally accepted that the two major alkaloids present in the rhizome and roots (herein referred to as "roots"), hydrastine and berberine, are at least partially responsible. These alkaloids are usually present in dried roots in concentrations of 2% to 10%. There has been extensive research on the medicinal effects of berberine, which gives goldenseal its yellow color and bitter flavor, but little or no research on the medicinal effects of hydrastine or whole root extracts.

Goldenseal has traditionally been used as a topical antiseptic and to treat fungal skin conditions. Now it is commonly administered to boost the immune system, although reports on this benefit are conflicting. Many herbalists believe that goldenseal increases the efficacy of other medicinal herbs. That is why you often see goldenseal sold in combination with other herbs such as *Echinacea*. Unfortunately, many sales of goldenseal products are the result of the urban legend that it will mask the presence of illegal drugs in urine tests.

Our earliest studies were on goldenseal fertility, including the influence of soil pH, nitrogen, and phos-

phorus on plant growth, root yield, and alkaloid content of roots (Davis 1996). After three years of growth, the total alkaloid level was highest in the lowest soil pH treatment and greatly reduced in the higher soil pH treatments (Fig. 2). In contrast, root growth increased dramatically with rising soil pH (Fig. 3). Plant survival and root yields decreased as nitrogen rate increased. Phosphorus reduced plant survival, but had no effect on root yields (data not shown).

Ginseng benefits greatly from the addition of calcium to the soil (Beyfuss 2000). Because goldenseal and ginseng grow under similar conditions, I conducted a field study on calcium effects on goldenseal (Davis 2003). In contrast to ginseng, however, increasing calcium decreased goldenseal root growth and alkaloid content and increased the incidence of foliar diseases (Table 1).

The influence of organic mulches on goldenseal growth and yield was also evaluated (Persons and Davis 2005). Hardwood bark, pine bark, pine needles, fresh hardwood sawdust, oat straw, and rye straw were compared to a bare ground treatment. Goldenseal grew best with the bark and sawdust mulches. Although straw is used in many northern states and Canada, in North Carolina its use resulted in low yields, high levels of disease, and extensive slug damage. In subsequent studies, we found the composted leaves also work well, are readily available and free (unpubl. data).

To study shade effects, goldenseal was grown for four years under polypropylene shade structures providing 30%, 47%, 63%, and 80% shade (Persons and Davis 2005). Root yield was highest in the 63% shade treatment, but the concentration of alkaloids was highest in the 30% shade treatment. Because some growers are paid for producing high alkaloids, the yield of alkaloids per unit area was calculated, revealing that the highest alkaloid yield was obtained in the 63% shade treatment.

A series of seed and vegetative propagation studies were conducted over several years (Persons and Davis 2005). One of the findings was that for vegetative propagation it is important to have a large number of fibrous roots on the rhizome propagules. As previously reported, goldenseal seed can be difficult to germinate and



Fig. 1. Goldenseal rhizome with roots.

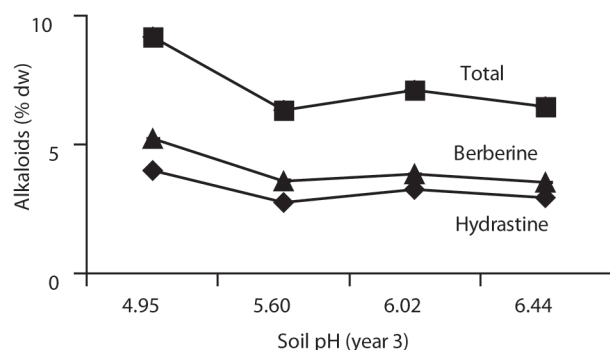


Fig. 2. Goldenseal root alkaloids in response to soil pH. The pH values indicated were the actual values at the end of the study.



Fig. 3. Goldenseal root growth in response to soil pH. The pH values indicated were the targeted pH values at the beginning of the study.

Table 1. Response of goldenseal foliar disease, root yield, and root alkaloids in response to soil calcium.

Calcium rate (kg/ha)	Total alkaloids	Dry root yield (g/m ²)	Foliar disease rating ^z
0	7.51a	412.1a	3.2a
2802	6.98a	318.0b	4.8ab
5605	6.41a	293.6b	6.8c

^zMean separation by Duncan's multiple range test, 5% level.

often don't emerge until the second spring after sowing. We found that the highest germination rates the first spring after sowing seed are often obtained when the seed is sown outdoors as soon after collection from the plant as possible.

Bloodroot

Bloodroot (*Sanguinaria canadensis* L., Papaveraceae) is one of the first plants to emerge and bloom in the spring. It is a low growing plant with waxy lobed leaves and showy white flowers. The thick rhizome is dark on the outside, with a cream colored flesh and blood red sap (Fig. 4). The rhizome has traditionally been used as a dye, to treat skin lesions, and to prevent tooth decay (Persons and Davis 2005). The demand for bloodroot has been low but steady for many years, and as a result, it has been almost exclusively wild harvested. This changed dramatically when a German company began using it as an appetite stimulant in cattle feed. It is now also being studied for the treatment of cancer (e.g., Ahmad et al. 2000). The major alkaloid believed to be responsible for its medicinal and anti-microbial properties is sanguinarine (Leung and Foster 1996).

Bloodroot studies are in progress on seed and vegetative propagation, tillage systems, and companion planting with other woodland botanicals (Persons and Davis 2005). Bloodroot is commonly propagated by rhizome cuttings and seed.

Black Cohosh

Black cohosh (*Actaea racemosa* L., Ranunculaceae) is a tall shrub like plant with feathery foliage and tall spikes of white flowers. The rhizome is large, knotty, and dark brown to black (Fig. 5). Black cohosh is a very popular woman's herb and is commonly used as an alternative to hormone replacement therapy to treat unpleasant menopausal symptoms (Lee 2005). It is in high demand, which is putting pressure on wide populations (McCoy et al. 2007). There is some cultivation underway, particularly in Canada and Germany, but prices remain too low to interest many growers (Persons and Davis 2005). Black cohosh is most commonly propagated by rhizome cuttings, but may also be propagated by seed.

Black cohosh was the subject of a Ph.D. dissertation at Clemson University in partnership with North Carolina State University (McCoy 2004). Studies focused on propagation in the forest and under artificial shade. I have continued studies on black cohosh looking at commercial production methods, companion planting with other woodland botanicals, disease, and growth greenhouse systems (unpubl.).

False Unicorn

False unicorn [*Chamaelirium luteum* (L.) Grey, Liliaceae], also known as fairywand and devil's bit, is an uncommon plant in most of our forests (Persons and Davis 2005). It has a small rosette of low growing leaves and puts up a tall flower spike (Fig. 6). The plants are dioecious and the sexes can be distinguished by the size



Fig. 4. Bloodroot rhizomes to be used for planting stock.



Fig. 5. Black cohosh rhizome.

and shape of the flower spike. False unicorn is another “woman’s herb.” It is also used to treat pain and poor appetite. Commercial production is limited. Research is being conducted on seed propagation, forest and artificial shade production, and shade level (unpubl.).

MEDICINAL HERBS FOR COMMERCE PROJECT

These herbs, and many more, were included in the three year, grant funded Medicinal Herbs for Commerce Project (Davis and Greenfield 2005; Hinsley 2005). The project was designed to answer the question, “Can North Carolina farmers grow the quality and quantity of medicinal herbs required by the industry at a price that is competitive in the global market?” The top raw material supply issues in 2004 were low quality, inexpensive imports, particularly from Asia (Nutrition Business Journal 2005). Herbs from China and India are priced as much as 75% less than US or European produced ingredients. We knew it would be a challenge to find a niche for North Carolina growers. We couldn’t compete on volume or price. We decided, instead, to focus on producing high quality cultivated material. Our goal is for all herbs sold under a North Carolina quality label (not yet created) to be certified organic, tested for heavy metals and, when necessary, tested for pesticides and bioactive constituents. All herbs will be produced and processed using industry approved Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) (not yet completed). Methods of cleaning, drying, packaging, and storage, specifically to maintain quality, are also being developed.

The statewide project began in 2004 with funding from the North Carolina Tobacco Trust Fund Commission and the North Carolina Department of Agriculture and Consumer Services. Applications were received from 128 growers from across the state who wanted to participate in the project. Sixteen growers were selected to receive \$5,000 grants to produce one to two acres of herbs. Many of these farmers were former or current tobacco growers. Some were already certified organic. Six buyers were recruited to purchase herbs from the growers and help determine what herbs to grow.

We taught the growers how to produce and market a wide variety of medicinal herbs. This included learning how to propagate herbs on a commercial scale. Transplants were produced in greenhouses; some in the float bed systems used for tobacco (Fig. 7). Throughout the growing process an emphasis was put on using equipment the growers already had, and we found that much of the equipment used to produce tobacco was appropriate for medicinal herbs. Production problems, such as diseases and insects, were handled by working together and sharing experiences. Across the state, weeds were, and continue to be, the biggest challenge to producing organic medicinal herbs in North Carolina.

A variety of harvesting and cleaning methods were tested for the different herbs that were grown. This included searching the countryside for old, abandoned crop harvesters to modify for harvesting herbs. Cleaning roots sufficiently to meet buyers’ standards was a real challenge for many of the growers. We found that a rotating drum with a water spray system was most effective. A pleasant surprise was finding that the propane fired dryers used for flue-cured tobacco in eastern North Carolina are well suited for drying medicinal herbs



Fig. 6. False unicorn plant.



Fig. 7. *Echinacea purpurea* transplants.

(Fig. 8). Unfortunately, the open air burley tobacco barns in western North Carolina are not appropriate for medicinal herbs. With funding provided by the North Carolina Rural Economic Development Center, through Land of Sky Regional Council, we designed and built two sizes of dryers for the project farmers located in the western part of the state (Fig. 9).

To determine the quality of the herbs produced throughout the state and possible problem areas, all crops were tested for heavy metals, pesticides, and bioactive constituents. Soils were also tested for nutrients and heavy metals. A variety of packaging methods were tried, including one using a tobacco baler. Overall, the buyers involved in the project were very impressed with the quality of the herbs produced, the yields obtained, and the professionalism of the growers.

The first year of the project was so successful that with continued funding from the North Carolina Tobacco Trust Fund Commission and the North Carolina Rural Economic Development Center for the existing cooperators, and new funding from the Golden Leaf Foundation for new cooperators, 40 farmers grew herbs for the project in 2005. One difference, however, was that most of the farmers did not receive grants the second year. We found this had a significant effect on the amount of time and effort the farmers could afford to put into their herbs. Based on our experiences, we strongly recommend issuing grants to farmers to produce a new crop. In 2006, 30 farmers from across the state grew 18 medicinal herbs for 8 cooperating buyers.

To study the economic aspects of medicinal herb production, all growers were required to keep extensive records on their expenses and labor. These data were helpful in our decision making and for the creation of enterprise budgets, which are constantly being updated as new data are collected. These budgets reveal that growers are currently netting from \$494 to \$34,568/ha, depending on the crop. Projections for some of the woodland botanicals, which won't be harvested for several more years, are as high as \$61,728/ha.

As part of this project, we have also conducted and sponsored several market studies. These included surveys of North Carolina medicinal herb growers, manufacturers, and national buyers. We also worked with an undergraduate agricultural economics class at the university on several market studies.

The information developed from these studies is available for everyone on the website, ncspecialtycrops.org/medherbs. The site contains step by step information on how to grow medicinal herbs, some enterprise budgets, and a series of production guides for specific herbs. To build a support system for growers across the state, we also conducted a series of medicinal herb training sessions for county extension agents and other agricultural professionals. Grower education sessions were held at conferences and workshops, and included creative learning techniques such as skits to demonstrate how to communicate with a buyer.



Fig. 8. Flue-cured tobacco kilns in eastern North Carolina.



Fig. 9. A large herb dryer designed and built for the project.

Project staff was also instrumental in starting the North Carolina Natural Products Association to support this growing industry. The creation of the North Carolina Medicinal Herb Buyer and Grower Directory has been very helpful for connecting growers and buyers. The association also provides a web based price index for its members and conferences. Information on the association can be found at the website ncnaturalproducts.org.

The success of this project was due in large part to the staff, a total of eight plus the author over the course of the project, who was available 24 hours a day, seven days a week to assist the growers with all production, harvesting, drying, packaging, storage, and marketing issues. Many of the farmers were completely unfamiliar with the crops they were asked to grow and had no former knowledge or experience with the medicinal herb industry. Many of them reported that it would have been almost impossible for them to produce a quality herb product without the project staff support because of their unfamiliarity with the plant or buyer's specifications.

REFERENCES

- Ahmad, N., S. Gupta, M.M. Husain, K.M. Heiskanen, and H. Mukhtar. 2000. Differential antiproliferative and apoptotic response of sanguinarine for cancer cells versus normal cells. *Clinical Cancer Res.* 6:1524–1528.
- Beyfuss, B. 2000. Soil nutrient characteristics of wild ginseng populations in New York, New Jersey, Maine, and Tennessee. *American Ginseng Production in the 21st Century Conf. Proc.*, Sept. 2000. Cornell Coop. Ext. Greene County, NY.
- Convention on International Trade in Endangered Species of Wild Fauna and Flora. 2007. cites.org. U.S. Fish and Wildlife Service, Division of Management Authority, Arlington, VA.
- Davis, J.M. 1996. Nitrogen, phosphorus, and soil pH effects on goldenseal (*Hydrastis canadensis* L.) growth, root yield, and quality. *HortScience* 31(4):673.
- Davis, J.M. 2003. Soil applied calcium influences growth, root yield, and alkaloid content of goldenseal. *HortScience* 38(5):855.
- Davis, J.M. and J.T. Greenfield. 2005. Diversifying into a new market-medicinal herbs. *HortScience* 40(4):1033.
- Hinsley, L. 2005. Medicinal herbs: A Carolina cash crop: growing our local farm economy. *New Life J.* June 2005, Asheville, NC.
- Lee, C.O. 2005. Complementary and alternative medicine patients are talking about: *Black cohosh*. *Clinical J. Oncology Nursing* 9(5):628–629.
- Leung, A.Y. and S. Foster. 1996. Bloodroot. *Encyclopedia of common natural ingredients used in food, drugs, and cosmetics*. 2nd ed. Wiley, New York. p. 92–93.
- McCoy, J.H. 2004. Seed and rhizome propagation of *Actaea racemosa* L. (black cohosh) and analysis of associated triterpene glycosides. Ph.D. Thesis. Clemson University, Clemson, SC.
- McCoy, J., J.M. Davis, N.D. Camper, I. Khan, and A. Bharathi. 2007. Influence of rhizome propagule size on yields and triterpene glycoside concentrations of black cohosh [*Actaea racemosa* L. syn *Cimicifuga racemosa* (L.) Nuttall]. *HortScience* 42:61–64.
- Nutrition Business Journal. 2005. China seeks to expand beyond commodity selling. *Nutr. Business J.* 10(8/9):19–21.
- Nutrition Business Journal. 2006. NBJ's annual industry overview, 2006. *Nutr. Business J.* 11(6/7): 1–13.
- Persons, W.S. and J.M. Davis. 2005. *Growing and marketing ginseng, goldenseal and other woodland medicinals*. Bright Mountain Books, Fairview, NC.