Production and Demand - A View to the Future of MAP

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Keywords: Herbs, markets, medicinal plants, phytopharmaceuticals

Abstract

The significant increase in demand for medicinal and aromatic plants during the past 25 years highlights the interest in using these plants for flavoring foods and drink and for pharmaceutical applications. The interest is fueled by changing demographics in Western countries, accented by expanding population levels of minorities and elderly. To meet the increased demand for quality medicinal and aromatic plant products during the next 25 years, growers and processors will need to focus on various aspects of production, plant protection/conservation, crop domestication, genetic transformation, and product standardization.

INTRODUCTION

The awakening of "modern" medicine and business to medicinal and aromatic plants as sources of healing and industrial agents during the past 25 years has increased demand for these plants and their extracts. During the next 25 years, the pressure to produce and collect more medicinal and aromatic plant material can be expected to continue, spurred by changing demographics and holistic health and cultural interests. To meet current and future needs for a greater variety and quantity of plant materials, investments in plant prospecting and cultivation are presently expanding, raising philosophical and practical questions on protection of plant habitats, conservation of genetic variability, and sustainability of agricultural practices. Such issues highlight the urgency for proactive understandings on acceptable production and quality standards among scholars, business people, and governments that can guide commerce in these plant materials.

MARKETS

Considerable effort has been made in the production, understanding, and utilization of medicinal and aromatic plants over the past few years. A comparison of the number of scientific articles on medicinal and aromatic plants for the past 25 years (as listed by abstracting services) (Ovid Technologies, 2001), indicates a movement from none to significant numbers of research reports (Table 1), demonstrating an upswing in scientific interest. Similarly, the commercial botanical market in the U.S., and undoubtedly other parts of the world, has grown with the demand for plant chemicals, essential oils, extracts, and other medicinal and aromatic plant products steadily increasing to meet the needs of industry and medicine (Brookman, 1999) (Table 2). In the phytopharmaceutical market, global sales are currently growing at over 7 to 8 percent per year (Gruenwald, 2000; Kane, 2001). Recent reports in Time magazine (Greenfield, 1998; Greenwald, 1998) indicate that in the U.S., the market for herb spiked drinks has moved from $20 million to $700 million in four years. The latest herbal survey (Richman and Witkowski, 2000) in Whole Foods magazine indicate that in the U.S. alternative food stores, approximately 36 percent of the foods contained medicinal or aromatic plant materials.

DEMAND

An informal survey at a local, natural products market in the USA, (Bread and Circus, Hadley, MA) in the spring of 2001, suggested that consumer interest in medicinal and aromatic plants relates primarily to health concerns (Table 3). Food processors supplying natural and regular food stores have noted this consumer interest and begun

marketing foods with names and labels that appeal to consumer concern for health promoting products (Figure 1). Demand and concern for such products is probably, to a large extent, influenced by the news media (Brevoort, 1998; Golden, 2001) as U.S. medicinal and aromatic plant growers reported increased sales following the placement of St. John's wort, echinacea, and gingko on the cover of Time magazine in 1998 (Time, 1998).

Demand for medicinal and aromatic plants, however, primarily reflects demographics. In the U.S., about one-third of the children born today are minorities versus one-fourth in the previous generation (U.S. Census Bureau, 2001). Hispanics and Asians are expected to account for 61 percent of the U.S. population growth from 1996 to 2025 (U.S. Census Bureau, 2001). Surveys suggest that the consumption of ethnic foods, which traditionally contain more herbs and spices than conventional "Western foods," is growing faster than any other main food eaten (Lavecchia, 2000). The globalization of markets and movement of immigrants appears to mean an international table of food loaded with aromatic plants as seasonings.

Demographically equal to globalization in importance for demand of medicinal and aromatic plants is an aging population. Given the current population, each minute from now until 2010, seven Americans will turn 55 years old (U.S. Census Bureau, 2001). Today, about 35 million Americans are over the age of 65 years. This aging population creates demand for such plant products as soy (*Glycine max* L.) and black cohosh (*Cimicifuga racemosa* (L.) Nutt.) (to relieve menopausal symptoms) and flax (*Linum usitatissimum* L. (with omega 3 fatty acids to protect the cardiovascular system) (Kluger, 1998; Nash, 1997). Spice sales increase as older individuals apply more of these products to enliven food (due to age-related loss of sensitivity in the taste buds) and to limit salt intake (due to restrictions imposed on older individuals to reduce blood pressure) (Table 4). An examination of age-related, target markets, the demand for medicinal and aromatic products should continue to increase in the U.S. as "Baby Boomers" (born 1946-1964) move to alternatives in food and medicine and "Generation X" (born 1965-1978), as an exploratory group that does not trust the established generation, almost demand alternatives (Hornblower, 1997) (Table 5).

Demand for medicinal and aromatic plants in the U.S. and probably most other locations, appears also to be driven by a lack of time. Everyone essentially seems to be time poor, a factor that, in personal observation, leads to a society which the convenience of using ready to eat foods, foods that traditionally use more aromatic plant materials, is preeminent for the homemaker. In addition, the homemaker has undoubtedly become better educated and taken a greater interest in healthier and tastier foods. By adding aromatic plant materials to prepared foods, the homemaker can personalize food preparation (Nabos, 2000).

PRODUCTION

With market demand for medicinal and aromatic plant products expected to remain strong, plant scientists need to focus on plant production, plant protection/conservation, crop domestication, genetic transformation, and product standardization in the near future. For this, the ground-work has been laid with the development of Good Agricultural Practices, Good Manufacturing Practices, and Good Collecting Practices (Máthé and Franz, 1999; Harnischfeger, 2000) (Table 6). By encouraging each grower, processor and collector to follow these guidelines, quality medicinal and aromatic plant products will be brought to market and endangered species will be protected.

In producing medicinal and aromatic plants, growers continue to need information related to cultivation. Propagation, culture, maintenance, harvesting, storage, processing, and marketing insights are required for sustainable production of medicinal and aromatic plants. Growers need such information for a variety of plants growing under a wide range of conditions.

Biodiversity needs to be protected in all ecological zones (Table 7). Although vital

as a repository of chemicals and genes, plants are frequently lost to habitat destruction as new homes, roads, dumps, and the other trappings of modern life constrict spaces not currently exploited. The loss of medicinal and aromatic plants is not just a third-world problem. Approximately 90 percent of the medicinal plant materials used by Europeans, for example, are wild-crafted (Lange, 1998). European countries are among the top world importers (120,000 metric tons annually) (25 % of world trade) (Lange, 1998).

In the U.S., officials at the Great Smoky Mountains National Park estimate over $5 million dollars of American ginseng (*Panax quinquefolius* L.) has been illegally harvested on park land in the last nine years (Nickens, 2001; Robbins, 1998). Rangers in National Forests of North Carolina have witnessed a decline in ginseng density form 29.8 plants per plot in 1979, to 5.7 plants per plot in 1999. To help win the battle for protection of plants, more information is needed on habitat loss, plant harvest rates, and world trade in collected medicinal and aromatic plant materials. The Hoosier National Forest in Indiana has been able to essentially stop the loss of wild ginseng plants by reducing permits to harvest (from 519 in 1996 to 0 in 2001) and enforcing regulations against collection of any plant materials (Marine, 2001). To fully protect and conserve medicinal and aromatic plant species, however, plant populations need to be stabilized, native peoples must recognize the value of the species, and consumers must become aware of the danger in loosing plants.

The lack of standardization of active constituents in medicinal plants has empowered the American press and medical profession to frequently label medicinal plants as worthless as pharmaceuticals (Golden, 2001; Gorman, 2001; Monmaney, 1998). Some recent evaluations of echinacea and St. John's wort products highlight this problem. In a study by Consumer Labs. com (Natural Products Industry Insider, 2001) on commercial echinacea products, 44 percent of the products failed tests for labeling, phenol content, contamination, or other quality measurements. A similar study (ConsumerLabs.com, 2001) on 21 preparations of St. John's wort noted samples did not contain the labeled quantities of hypericin nor hyperforin. To overcome this negative connotation, market quality medicinal and aromatic plant products must approach consistent levels of research-defined, bioactive ingredients (Table 8). This standardization will be difficult as the chemical composition of medicinal and aromatic plants is known to vary according to genetic organization of the plant and the growth environment (Miller, 2001; Salamon, 2001) (Table 9).

With the possibility of gene transformation and genetically modified organism, the future concept of secondary metabolites associated with medicinal and aromatic plants may be quite different from that of the traditional medicine man who developed remedies through trial and error over several years. A recent review in *Biotechnology and Forestry* (Bajaj,1999) indicates that of the 200 species of plants used in genetic transformation experiments, 70 are medicinal plants. These experiments are attempting to increase the level of bioactive constituents and to enhance plant growth. The future of genetic transformation, if accepted by society, may well involve the movement of entire gene sequences for specific secondary metabolites from a wild or difficult to grow medicinal or aromatic plant to a more commonly cultivated plants for production of the bioactive constituents.

The recent unraveling of the human genome promises more detailed ways of diagnosing and predicting susceptibility to disease and the chemicals needed for treatment. Through pharmacogeomics, therapy promises to be individualized and base on genome targets. This brings us to the possibility of in the future of medicinal and aromatic plants with secondary metabolites from which individuals can select plant constituents for individualized treatment.

SUMMARY

Although cultivation of plants will surely be necessary as part of a world-wide conservation movement aimed at protecting genomic diversity in nature and at producing more dependable supply levels, the nature of such future cultivation is unknown.

Completion of the human genome project will likely lead to the visualization and need for designer molecules that mimic or initiate biochemical processes within the body. Plants, along with fungi and marine life, can be expected to be the primary resources mined for these molecular chemical entities. Inevitably, both chemical and gene surveys of all plant species will be inaugurated in the search for molecular constituents or fragments with desirable attributes. Biotechnological procedures can be expected to lead to cultivation of medicinal and aromatic species with enhanced constituent production or to production of food and feed crops modified through movement of gene systems to produce essential oils and other desirable compounds. Yet, the impact of any gene transformations on plant chemistry, on farming and collecting practices in producer countries, and on acceptance of genetic modifications by consumers remains questionable.

Within the immediate future, medicinal and aromatic plant scientists, businesses, and government agencies must look to developing tracking systems for eco-certification of medicinal and aromatic plants to ensure conservation and protection of plant habitats, entering collaborative arrangements with non-traditional partners to improve and promote plant-body interactions related to medicinal and aromatic plants, and staying dedicated to basic research before application of medicinal and aromatic plants through product development and promotion.

ACKNOWLEDGEMENTS

This material is based upon work supported by the Cooperative State Research, Extension, Education Service, US Department of Agriculture, and Massachusetts Agricultural Experiment Station under project No. 729. Publication No. 3302.

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Tables

Table 1. Research trends in medicinal and aromatic plants.

Year	Medline	Agricula	CAB Abstracts
	(number of publications noted by abstracting service)[1]		
1976	0	0	0
1995	0	7	280
1997	1036	97	470
1999	1249	96	479

[1] Data collected via Ovid Technologies, Inc., 2001

Table 2. U.S. botanical markets.

Item[1]	1993	1998	2003
-- ($ million) --			
Plant chemicals	$1185	$1890	$2935
Essential oils	$465	$625	$820
Botanical extracts	$268	$560	$1120
Gums, gels, polymers	$274	$392	$500
Other	$178	$313	$495

[1] Data of Brookman, 1999.

Table 3. Customer reasoning for purchasing natural products.

- Grown and processed to improve health
- Contain only natural ingredients
- Protect the environment
- Preserve social and cultural values
- Unadulterated products
- Satisfy need to feel good (family value)

Data from a informal survey of natural product customers at Bread & Circus grocery store in Hadley, MA.

Table 4. Changes in U.S. aromatic plant consumption.

Spice[1]	1979-1993	1994-1998	Change
	(Average use in 1000 lb)	(%)	
Pepper	67,415	100,933	+ 50
Capsicum	43,340	85,038	+ 98
Mustard	98,333	189,510	+ 93

[1] Data from Lavecchia, 2000.

Table 5. Potential markets and population.

Market classification	Size[1]
Swing/WWII (1933-1945)	30.7 million
Baby Boomers (1946-1964)	76.8 million
Generation X (1965-1978)	52.4 million
Baby Boomlet (1979-1994)	77.6 million

[1] Data from U.S. Census Bureau, 2001

Table 6. Features of GAP, GCP, and GMP.

- Make positive plant identification.
- Maintain purity and cleanliness..
- Manage to preserve bioactivity

Table 7. Steps to plant protection.

1. Stabilize (protect) endangered species
- Develop effective laws and regulations
- Train protective forces

2. Collaborate with traditional healers
- Work collectively to warranty security
- Promote propagation of endangered species

3. Develop consumer awareness
- Educate businesses and governments

4. Support conservation agencies

Table 8. Assumptions associated with standardization.

- Active constituents are known
- Mechanisms of action are known
- Manufacturers use comparable assays
- Quality standards are available
- Constituent additions do not affect product
- Standardization is desirable

[1] Modified from Miller, 2001.

Table 9. The environment and essential oil composition.

Growth locality[2]	Essential oil	Constituents[1]			
		Fa	Bo	Ch	BoA
		(% of total oil)			
N. Hrabovec	0.61	3.8	4.9	10.8	34.6
Vranov n/T	0.82	4.1	5.2	7.6	48.3
Sirnik	0.86	4.0	6.2	10.6	44.0
Moravany	0.93	4.6	9.6	9.9	37.9

[1] Fa = farnesene, Bo = α-bisabolol, Ch = chamazulene, and BoA = bisabolol oxide

[2] Data of Salamon, 2001.

Figures

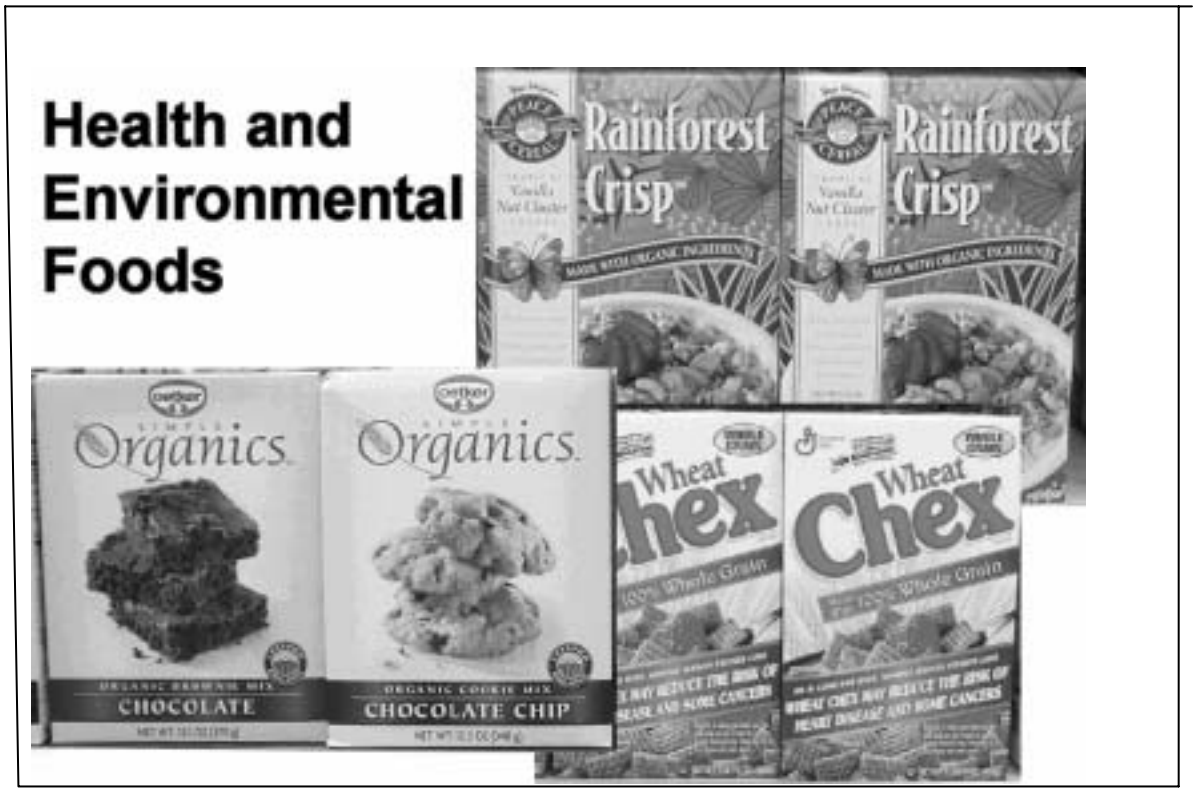

Fig. 1. Labeling to meet consumer preferences.