

## Medicinal and Aromatic Plants—Future Opportunities

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During the past 30 years, medicinal and aromatic plants in the United States have moved from essentially unknown, minor agricultural plants into crops that many farmers consider producing as an alternative to usual plantings of food and feed crops. The attraction of medicinal and aromatic plants as worthy farm crops has grown due to the demand created by consumer interest in these plants for culinary, medicinal, and other anthropogenic applications. As racial diversity in the US has expanded, immigrants from countries in which herbs and herbal medicines are commonly used to flavor foods and treat illnesses have introduced other Americans to a diverse range of plant materials. Indeed, market trend surveys indicate that mainstream American consumers will purchase 75% of the ethnic foods during the next decade (Packaged Facts 2004a).

Farmers growing medicinal and aromatic plants, similar to farmers in other agricultural systems, begin each growing season with hopes for success in producing a crop that brought to market will more than repay the expense of production. Yet, in addition to traditional cropping uncertainties of weather, pests, and other limitations, the medicinal and aromatic plant farmer also faces changes in consumer interest, international trade policies, and other issues that control demand. For these reasons, an understanding of future opportunities in the medicinal and aromatic plant industry (WHO 2003) is necessary to enable US growers to envision and invest in medicinal and aromatic crops that will meet market demands.

### HISTORICAL PERSPECTIVES

The initiation of medicinal plant and aromatic production, as a gathering or cultivation of plant materials, is lost to history, but most likely began at or near the time of the first afflictions and the recognition that smelling, chewing, and/or eating some plant materials could provide relief from nausea, pain, and/or other infirmities. Those plants containing the unique chemical profiles that offered pain relief, pleasant aromas, and enhanced food flavors would soon be renowned and much valued by early humans, leading to associations among certain ailments, plants, and “feeling better” (Friedman and Adler 2001). Thus, these plants, now known as medicinal and aromatic plants, and their extracts became the main source for medicines, seasonings, colorings, preservatives, and other similar items used in societies, sustained by myths and traditions developed to explain the almost “magical” powers of selected species and to transmit the accumulation of acquired knowledge about these species before the era of written records.

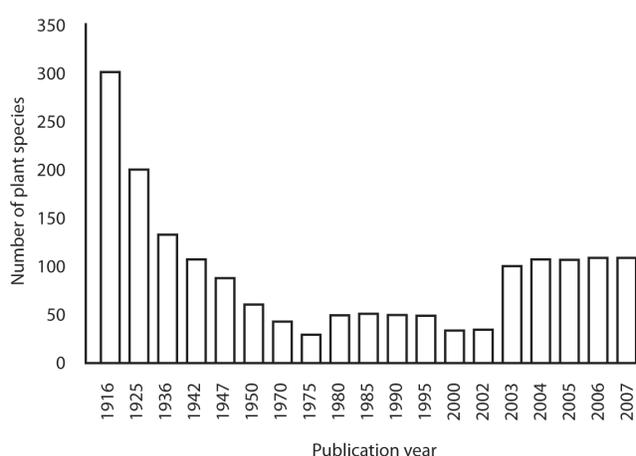
As continued experimentation with various plant materials demonstrated the benefits of having specific plants immediately available for use in medical treatment and food flavoring, husbandry of these plant species undoubtedly started. Although the collection of plants probably remained the primary source of medicinal and aromatic plant material for a considerable period of time, cultivation and growth of plants could be expected to have begun in small garden plots and botanical collections. As human migration led to settlements within various ecosystems, species having medicinal and aromatic properties specific to those regions would be discovered, leading to a collection of plant materials with a variety of uses and the initiation of trade among neighboring groups for unavailable plant materials. This initial exchange of plant material could be expected to spread and with the passage of time lead to overland and sea trade routes, including those that brought plant materials from Asia to Europe to meet the demand for spices as seasonings and medicines. New insights into the causal agents of poor health were acquired during the 18<sup>th</sup> and 19<sup>th</sup> centuries (such as the germ theory developed by Pasteur and Koch, use of disinfectants by Lister, plus the work of many others), but medicinal and aromatic plants remained the primary pharmaceutical agents into the early 1900s (Craker et al. 2003; Craker and Gardner 2006).

Technological innovations and political and social forces at the beginning of the 20<sup>th</sup> century caused a rapid decline in the use of plants as medicine. The development of sulfa drugs in the 1930s and the synthesis of organic chemicals in the 1940s produced additional sources of medicines and, indeed, became the preferred method for treatment in some countries, especially in America where the 1910 Flexner Report (Flexner 1910) and the American Medical Association (AMA 2006) indicated only trained physicians using allopathic medicines should be allowed to practice medicine. At the same time, Western societies, modernized by the industrial revolution, became infatuated with the social and economic changes following World War I and identified with

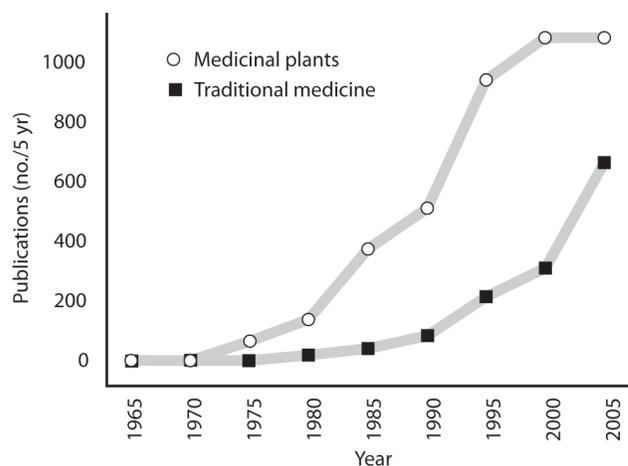
the new, synthesized chemical medicines, requesting these in place of herbal medicines and resulting in a decline in the use of plants and plant extracts until the mid-1970s (Craker et al. 2003). By the middle of the 20<sup>th</sup> century, medical practitioners and consumers were demanding scientific proof of efficacy through double-blind clinical trials in contrast to the traditional use and mythological associations linked with medicinal plant materials.

The decline in the use of herbal preparations as medicines can be inferred from the decline in listing of medicinal species in the *U.S. Pharmacopeia* and *National Formulary* (USP\_NF 1916-2006) beginning in the early 1900s (Fig. 1). At the start of the 20<sup>th</sup> century, over 40 percent of the listed drugs (mostly crude extracts) originated from plants, but by the mid-1970s, the listing of plant materials had decreased to less than 5% of the drugs in the *Pharmacopeia* and *Formulary*. In the intervening years, the American concept of medicine had evolved from a collection of plant materials with a mixture of constituents to a medication containing only one chemical formula (Craker and Gardner 2005). The collection of laws and regulations, originally developed to protect the public from worthless health products, unsanitary manufacturing practices, and unscrupulous sales people, limited access to phytomedicines and medical practitioners that used phytomedicines (Masiello 1999).

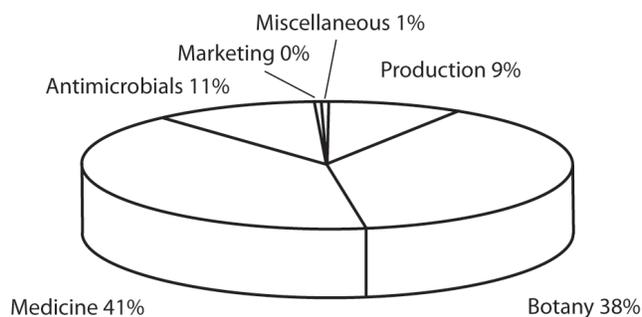
With decreased demand, interest in the cultivation of medicinal and aromatic plants in the United States decreased. The US Department of Agriculture, which published cultivation guides for farmers growing medicinal aromatic plants in the first half of the 1900s, failed to provide such guides in the latter half of the 20<sup>th</sup> century (Craker et al. 2003). A sampling of horticultural and garden books published in the early 1900s frequently contains cultivation information on aromatic and medicinal herbs, but similar books published as late as the 1980s mention these crops only briefly and focus on culinary herbs. Few research articles on medicinal and aromatic plants were published in the scientific literature from the 1940s to the 1990s (Fig. 2). Most current research on medicinal and aromatic plants is focused on the medicinal uses and botany (Fig. 3).



**Fig. 1.** Plants in the *US Pharmacopeia* and *Formulary*. Data collected by a count of plants and plant extracts listed in the *Pharmacopeia* and *Formulary* for publication years listed.



**Fig. 2.** Scientific publications on medicinal plants and traditional medicine in Africa. Data from other global regions and for individual plants demonstrate the same trend. Publication count from those listed PubMed (a service of the US National Library of Medicine), each point represents the sum of the previous five years.



**Fig. 3.** Research interests in medicinal plants for 2006. Data collected by a count of abstracts published during 2006 in the Medicinal and Aromatic Plants Abstracts, National Institute of Science Communication and Information Resources, The Council of Scientific & Industrial Research, New Delhi, India (Doreswamy 2006).

The revival of US interest in culinary herbs appears to have been initiated by a revival of interest in natural products in the 1960s and driven by demographic changes in the population. For example, the current population growth rate among those of Asian and Hispanic origin, cultural groups acknowledged to enjoy more highly spiced foods than cultures of European origin, leads all ethnic groups at 61% (US Census 2000). In addition, an aging American population (US Census 2000) began to use medicinal and aromatic plants to stimulate aging taste buds and, for health reasons, as substitutes for salt. Changes to the family structure in which both parents worked led to increased use of prepared foods that contained more spices. As consumers became more worldly oriented and more knowledgeable about health during the 1980s and 1990s, interest in organic and natural foods placed new emphasis on the benefits of using medicinal and aromatic plants. The expansion of this American interest in medicinal and aromatic plants was promoted by observations on the use of alternative medicines in China during President Nixon’s visit to that country in 1972.

While conventional medicine establishments generally disapproved of the revival of herbal medicines in the US (Fontanarosa and Lundberg 1998; Browne 2005; Winnick 2005), consumers began to explore and use these products as evidenced by the enhanced market for dietary supplements during the 1990s, increasing in sales from less than \$1 billion annually in the early 1990s to over \$4 billion annually by the end of the 1990s (Huff 2006). With passage of the Dietary Supplement Health and Education Act (DSHEA) in 1994 (FDA 1994), sales of supplements, many of which are herbal products, continued to increase despite warnings about lack of efficacy and health hazards from the conventional medicine system in the US (Cupp 1999; Klepser and Klepser 1999) (Fig. 4). The aging population of the US, which needed increased health care, discovered herbal medicines were an attractive alternative to the comparatively high costs of conventional medicines (Powers 2006). The use of herbal medicines in the US by regular and occasional users increased from 2% of the population in 1990 to 37% in 2000 (WWF 2000). Yet, this development in the US is in contrast to most other countries that had remained committed to the use of herbal medicines as part of their health care system throughout the 20<sup>th</sup> century. In most areas of Africa and Asia, the traditional healer continues to be the main source of medical care into the 21<sup>st</sup> century, primarily due to the relatively high cost of conventional medicines and the lack of trained physicians (Craker and Gardner 2006).

Globalization of trade in the late 1990s and early 2000s and concerns about the conservation of genetic diversity affected the cultivation of medicinal plants. As demand for medicinal species in the US grew, domestic and foreign growers increased production. Quality standards for plant material increased with processors and consumers demanding clean (no physical nor chemical contaminating adulterants), consistent (dependable production and bioactive levels), and certifiable (identifiable for origin and history) products (Khan et al. 2005). Research on medicinal and aromatic plants initiated in the 1980s and 1990s led to improvements in production of plants, extraction of bioactive constituents, and confirmation of medicinal applications (Khan et al. 2005).

Yet, some aspects of globalization have been challenging for medicinal and aromatic plant growers. For example, the production of cultivated American ginseng (*Panax quinquefolium* L., Araliaceae) shifted from the traditional center in Wisconsin to Canada (Table 1) during the 1990s and then more recently to China.



**Fig. 4.** Newspaper warning about use of medicinal plants as medicines. Illustration is headline from Health & Fitness section of New York Times, February 9, 1999 issue (Brody 1999).

**Table 1.** Production of American ginseng.

Location	American ginseng production (t) <sup>z</sup>		
	1985	1992	2004
Wisconsin	471	523	227
Canada	93	303	1012
China	-?-	272	+++

<sup>z</sup>Estimates using information gathered from several sources; Wisconsin and Canada = export data.

Growers in each production center have been affected by changing market places. Where possible, American growers of ginseng have increased planting of wild-simulated versus field grown ginseng in efforts to maintain market share. Similar production shifts, yet unidentified, may also be occurring or occur for other medicinal and aromatic species (Harry 2001).

In the late 1990s and early 2000s, a number of new medicinal and aromatic plant products were brought to market. Cosmeceuticals, products formulated to improve the health and appearance of the skin, contain a number of plant extracts, such as *Aloe barbadensis*, *Celastrus paniculatus*, *Cyperus scariosus*, *Ginkgo biloba*, *Myrtus caryophyllus*, and *Withania somnifera*, to protect and rejuvenate the upper layers of the skin (L'amar 2006). In 2004, US consumers, primarily aging "baby boomers" wanting to avoid visual signs of aging, spent \$12.4 billion on cosmeceuticals (Barret 2005). The development, marketing, and sales of health and wellness drinks (herbal and flavored teas and energy, health, functional, and sports drinks that often contain herbal extracts) exploded after 2000, with total sales of several billion dollars in current markets (Table 2) (Lipson 2005; Mintel 2004a,b; Packaged Facts 2006). Consumer choice spending has led to interest in natural products for animal care (feed and non-feed items labeled natural or organic), significantly increasing demand during the past few years (doubling from 2002 to 2003 and expected to reach \$1 billion in the US by 2009) (Packaged Facts 2004b) for medicinal and aromatic plants with a history of traditional veterinary use (Pieroni et al. 2006).

## THE FUTURE

Demand for medicinal and aromatic plants in the United States can be expected to continue for the near future, although the rate of sale increases for many medicinal and aromatic plant materials will probably not match those exhibited during the 1990s. While the global market for medicinal and aromatic plants can be estimated to be at least US\$60 billion (WHO 2003), exact market figures and market trends are difficult to ascertain due to herbal materials in a vast array of products being sold through a large number outlets, ranging from entrepreneurial sales over the internet to mass market sales in supermarkets and natural product stores. In addition, favorable or unfavorable press reports (Brody 1990, 1999; Browne 2005) about a particular herbal product can cause an especially strong growth or a rapid decline in interest and sales (Blumenthal et al. 2006; Craker and Gardner 2006; Google Trends 2006). Most market surveys (Blumenthal et al. 2006; Dainells 2006; Hartman Group 2006) suggest only a slow increase in overall demand within the US for medicinal and aromatic plants, as compared with the 1990s. If the US medical establishment fully accepts medicinal plants as part of the mainstream, conventional medicine system (following the example of Asian and European countries), sales could be expected to significantly increase.

Over the near future, continued globalization of trade and markets along with ethnobotanical exploration can be projected to continue to bring awareness of new plant materials for home, medicinal, and industrial use. In addition to the demand created by population diversification and aging in the past 10 years (US Census 2000), the relatively high cost of medical treatment in the US (Craker and Gardner 2006; Schippman et al. 2005, 2006) and the failure of conventional medicine to have satisfactory treatments for ailments, such as those associated with obesity and diabetes (Table 3), and currently incurable afflictions, such as HIV, cardiovascular and degenerative diseases, and cancer (JTF 1999), have stimulated many healthcare consumers to test alternative medicines (AARP 2007). The search for disease cures have led to global cooperation and extended research efforts on the cultivation and improvement of such medicinal plants as *Artemisia annua* for treatment of malaria, a disease estimated to be responsible for almost three million deaths annually over the past 30 years, as synthesized drugs became ineffective (IPBO 2004; WAC 2004).

**Table 2.** Health and wellness market drinks.

Drink	Estimated market (million \$)
Specialty & herbal teas <sup>z</sup>	500
Energy drinks <sup>y</sup>	1400
Sports drinks <sup>y</sup>	2721
Functional drinks <sup>x</sup>	8749

<sup>z</sup>US market for tea and ready to drink beverage, 2004 (Lipson 2005).

<sup>y</sup>Energy drinks had off-premise sales of \$1.1 billion in 2005 and estimated on-premise sales of \$600 million in 2004 (Mintel 2006a); Sports drinks estimated off-premise sales for 2005 (Mintel 2006a).

<sup>x</sup>Functional beverages—US as estimated for 2006 (Mintel 2006b). Functional drinks include several classes of beverages, including energy drinks, soy drinks, & fortified fruit juices.

Rising incomes in Asia are likely to raise the standard of living of residents, increasing demand for additional medicinal and aromatic plants as the population suffers from the detrimental affects of ageing, weight gain, and other medical problems that frequently occur in relatively prosperous societies (Gross 2001).

The increase in demand for medicinal and aromatic plants will likely continue to threaten native species in some localities. Price differentials between wild and cultivated plants due to a desire for the wild material or the unavailability of cultivated plant material currently encourages unsustainable collection practices in some localities (WWF 2000), especially in economically depressed regions that lack resources for protecting plants (ITC 2001; Schippman et al. 2002). The financial gains for collecting and selling local plant material frequently represent a substantial share of total income for many medicinal plant collectors in several regions (Schippmann et al. 2005, 2006). As an example, collection of wild ginseng (valued at \$2 million in 2002) (DOF 2006) in West Virginia can be a considerable addition to budgets of poor families (average income <\$10,000) (CBPP 1997). In many instances, a switch to cultivated species to protect endangered species is problematic due to the difficulty of duplicating the demanding environmental requirements of wild species in cultivated fields and due to the socio-economic impact on native cultures and local economies when cultivation is shifted to large scale production outside the local area (Leaky and Izac 1997; Schippman et al. 2002, 2005; Shanley and Luz 2003). In addition, consumer concern about protection of endangered species and prosperity of native cultures (FAO 2003), factors that may decrease or increase medicinal plant purchases, respectively, will most likely require labeling to demonstrate ethical wild-crafting practices and fair-trade (a guarantee of a just financial return to the grower/collector for work).

Continued loss of habitat in the future due to deforestation and development can be expected to remain a threat to many medicinal and aromatic species in both developing and industrialized countries (Shanley and Luz 2003; Schippmann et al. 2006). In tropical areas such as Amazonia and West Africa, changing land use from logging, ranching, mining, and agriculture have been identified as responsible for changes in forest composition and structure (Uhl et al. 1991; Ekpe 2002), frequently creating environments unfavorable to growing native medicinal and aromatic species and posing detrimental affects on traditional healthcare (Ekpe 2002). Such destruction in natural ecosystems and the resultant losses in medicinal and aromatic species will surely increase pressure for preservation and cultivation of endangered flora. Shortages of available plant material for collection in the natural environment of medicinal and aromatic plants can be expected to lead to increased costs for plant material until cultivation systems are in place. Estimates suggest the number of plant species used for medicinal purposes, most of which are collected in the wild, is more than 52,000 (Schippman et al. 2002).

In current medicinal and aromatic plant markets, the demand is for organic products, matching the demand for organic foods (Adam 2005; Hartman Group 2006) and suggesting that the current base of customers for medicinal and aromatic plant products are the same as those that purchase organic foods (Hartman 2007). As consumers become more involved with health and wellness, future medicinal and aromatic plant markets will need to respond to this demand by consumers for quality plant material, most likely produced sustainably and uncontaminated by either synthetic pesticides or by genetically modified organisms. As processors expand to meet the demand, global trade in medicinal and aromatic plants can be expected to increase to make available certified organic plant material needed for the development of new formulations and marketing concepts (Hartman Group 2006). Sales of medicinal and aromatic plant combinations and herbal drinks have posted market gains during the past few years (Ferrier et al. 2006) by offering the liveliness and vigor of youth, the promise of vitality, simplicity, and sustainability that can be expected to remain key market concepts in selling medicinal and aromatic products in the near future (Hartman Group 2006).

Sales of organic non-food items (most of which could be expected to contain medicinal and aromatic plants or plant extracts) increased by one-third in 2005 (OTA 2006). The *Nutrition Business Journal* (NBJ 2007)

**Table 3.** Obesity and diabetes in the US.

Designation <sup>z</sup>	Population (%)
Overweight (BMI ≥ 25)	64.5
Obese (BMI ≥ 30)	30.5
Severely obese (BMI ≥ 35)	4.7
Diabetes	7.0

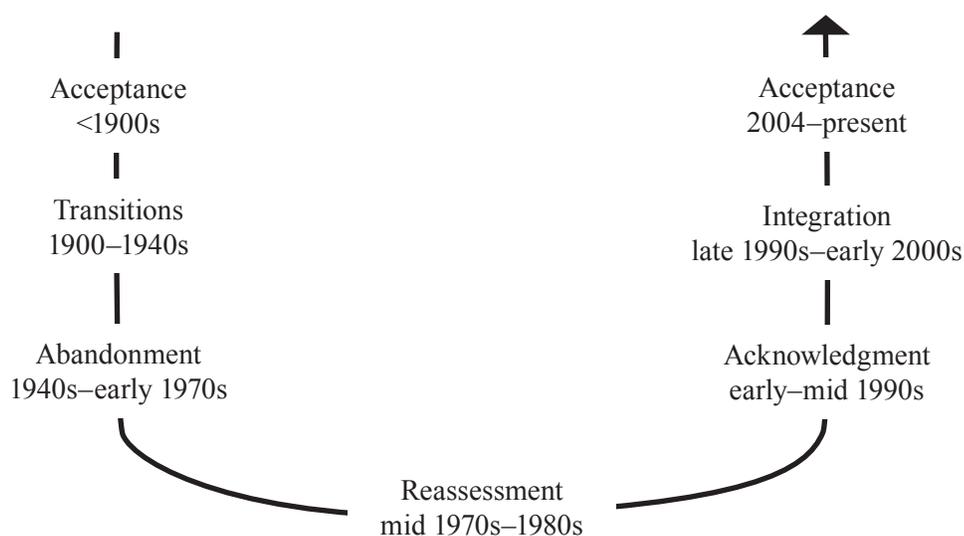
<sup>z</sup>BMI = body mass index; data from summary table of American Obesity Association (AOA 2005). Diabetes data for 2005, sourced from National Diabetes Information Clearing House (NDIC 2005). Diabetes costs the US economy about \$132 billion each year.

reports that sales of dietary supplements, many of which contain medicinal plant materials, increased by 4.5% to \$21.3 billion in 2005, with sales forecast to grow 1.5 to 2 times faster than that of the US economy. Aromatic plants and plant extracts have become extensively used in flower arrangements and the fragrance industry. The market for candles and home fragrances, many of which contain aromatic plants and/or plant extracts, reached an estimated \$8.4 billion in 2004, a growth of 14.1% from 2003 (Unity Marketing Inc. 2005) that has primarily been attributed to the popularity of aromatherapy and scented candles (Elson 1999). Incense, made from a combination of fragrant gums, resins, woods, and spices has an estimated market value in the US of \$17 million (\$12.4 million imports and \$4.6 million exports) (Knight et al. 2001).

In addition to a role in traditional and in alternative and complimentary medicinal markets, medicinal and aromatic plants maintain a role in both over-the-counter and prescription drugs in conventional medicine. An estimated 25% of conventional pharmaceuticals are derived from medicinal plants (Farnsworth 1988). The estimated global market for plant derived drugs was \$18 billion in 2005, and is expected to grow to \$26 billion by 2011, with the US and Canada accounting for over 50% of the market demand (Pharmalicensing.com 2006). Of new interest is the development of plant-made pharmaceuticals where plants are being used to produce therapeutic proteins that could be used for treating diseases. Currently, common food and feed crops, such as alfalfa, barley, corn, rice, and safflower, are being used to produce the proteins that are subsequently isolated from the plant material. Although these products are not yet on the market, they may offer medicinal plant growers and processors new business opportunities in the future.

In the past few years, the conventional American medical system seems to have done a “U-turn” and accepted the use of medicinal and aromatic by patients (Fig. 5). Yet, inconsistent product quality, due to genotypic variation within plant species and environmental effects that alter constituent levels and distribution, remains an issue for use of medicinal and aromatic plants that growers and processors can expect to continue to face in the immediate future. Quality is frequently judged by color, aroma, taste, and effect of the plant material, although the levels of various chemical constituents may also be analyzed in facilities equipped or associated with testing laboratories. Additional terminology associated with medicinal and aromatic plants and used in an effort to judge quality aspects include organic (produced according to certification rules, including without the use of synthetic fertilizers or pesticides) (USDA 2006), wild-crafted (collected in the natural environment with no human contact before harvest), woods-grown (planted in natural environment with protection and care during growth), and commercial (produced with the possible use of synthetic pesticides or fertilizers).

Good agricultural practices, good collection practices, and good manufacturing practices have been developed to help growers, collectors, and processors to produce and maintain quality medicinal and aromatic plant material (WHO 2003; FDA 2004). In the future, these guidelines are likely to be revised and become one



**Fig. 5.** The American “U-turn” in acceptance of alternative medicines. Modified from Winnick (2005).

of the standards for quality determination. Such practices should help reduce adulterants and contaminants in medicinal and aromatic plant materials brought to market. Such adulterants (extraneous and fake plant material, counterfeit goods, synthetic drugs, and other non-specific materials) are frequently a health hazard and deprive the consumer of expected benefits.

## CONCLUSIONS

In the US and world markets, demand for medicinal and aromatic plant materials should continue into the foreseeable future. Current and future changes in demographics (age, culture, incomes, diseases, and other human conditions), public concern about healthcare (availability and expense), and familiarity with plant products (press reports, advertising, education, and scientific reports) can be expected to bring more people to sample and commit to using medicinal and/or aromatic plant products. Acceptance of alternative and complimentary medicines by conventional medical systems should reassure those questioning the use of plant materials, enhance demand for medicinal plants, and help establish a partnership between conventional and alternative medicines for the benefit of the consumer. Rising consumer interest in use of natural and organic products (Kroner 2006), in protection of endangered species (FAO 2003), in intellectual property rights of native populations (Persley 1997), and in the value of fair trade (Brinckmann 2004) will most likely continue, bringing a need to validate plant sources and, in some instances, a preference for cultivation.

Consumer interest in medicinal and aromatic plants is continuing to change in the US marketplace as segments of society become more aware of the possible relationships between good health and healthy living. The concept of Western medicine in which health is defined as absence of disease and all body systems functioning is moderating and becoming more adjusted to the idea of balance within the mind and body. As consumers become better informed about issues of food, health, and nutrition, they also become better informed about the controversies and concerns surrounding conventional medicine, genetically engineered products, pesticide contaminated food, and similar issues. Such consumers frequently choose or move towards a life-style likely to bring them into organic and natural food stores and to try alternative medical care (SPINS 2004). Increased use of medicinal and aromatic plants will most likely be part of this evolution.

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