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Health-promoting properties of common herbs[1,2]

Winston J Craig

ABSTRACT Herbs have been used as food and for medicinal purposes for centuries. Research interest has focused on various herbs that possess hypolipidemic, antiplatelet, antitumor, or immune-stimulating properties that may be useful adjuncts in helping reduce the risk of cardiovascular disease and cancer. In different herbs, a wide variety of active phytochemicals, including the flavonoids, terpenoids, lignans, sulfides, polyphenolics, carotenoids, coumarins, saponins, plant sterols, curcumins, and phthalides have been identified. Several of these phytochemicals either inhibit nitrosation or the formation of DNA adducts or stimulate the activity of protective enzymes such as the Phase II enzyme glutathione transferase (EC 2.5.1.18). Research has centered around the biochemical activity of the *Allium* sp. and the *Labiatae*, *Umbelliferae*, and *Zingiberaceae* families, as well as flaxseed, licorice root, and green tea. Many of these herbs contain potent antioxidant compounds that provide significant protection against chronic diseases. These compounds may protect LDL cholesterol from oxidation, inhibit cyclooxygenase and lipoxygenase enzymes, inhibit lipid peroxidation, or have antiviral or antitumor activity. The volatile essential oils of commonly used culinary herbs, spices, and herbal teas inhibit mevalonate synthesis and thereby suppress cholesterol synthesis and tumor growth. *Am J Clin Nutr* 1999;70(suppl):491S–9S.

KEY WORDS Herbs, herbal products, herbal medicines, cancer, cardiovascular disease, immunity, phytochemicals, flavonoids, terpenoids, antioxidants, garlic, licorice, green tea, flaxseed, chronic disease prevention

INTRODUCTION

The National Institutes of Health opened its Office of Alternative Medicine in 1993 to provide support to qualified investigators wanting to systematically study unconventional therapies. According to a survey published by Eisenberg et al (1) in 1993, ≈1 of every 3 Americans used at least one unconventional therapy per year, and most of those used the unconventional therapy for chronic rather than life-threatening medical conditions. People seek solutions without side effects for problems such as arthritis, allergies, insomnia, headaches, anxiety, and depression (1).

Today we are witnessing a great deal of public interest in the use of herbal remedies. Herbal medicine is based on the premise that plants contain natural substances that can promote health and alleviate illness. According to the Eisenberg survey (1), 3% of the respondents had used herbal medicine within the past 12 mo. The annual sale of medicinal herbs and related commodities in the United States now exceeds $2 billion.

In herbal medicine the term *herbs* is used loosely to refer not only to herbaceous plants but also to bark; roots; leaves; seeds; flowers and fruit of trees, shrubs, and woody vines; and extracts of the same that are valued for their savory, aromatic, or medicinal qualities. The botanical term *herb* refers to seed-producing plants with nonwoody stems that die down at the end of the growing season.

Plants have played a significant role in maintaining human health and improving the quality of human life for thousands of years, and have served humans well as valuable components of seasonings, beverages, cosmetics, dyes, and medicines. The World Health Organization estimated that ≈80% of the earth's inhabitants rely on traditional medicine for their primary health care needs, and most of this therapy involves the use of plant extracts or their active components. Furthermore, many Western drugs had their origin in a plant extract. Reserpine, which is widely used for the treatment of high blood pressure, was originally extracted from the plant *Rauwolfia serpentina*, whereas digitalis, used as a heart stimulant, was derived from the foxglove plant (*Digitalis purpurea*). The Chinese herb ephedra (*Ma huang*), which contains the active substance ephedrine, was used early on for the treatment of asthma, whereas salicylic acid (a precursor of aspirin) was obtained from willow tree bark (*Salix alba*) to help relieve fevers. Over-the-counter laxatives commonly contain psyllium, senna, or *Cascara sagrada*. The laxative effect of the latter 2 herbs is due to the presence of anthraquinones, which stimulate peristalsis, whereas the mucilages in psyllium provide a bulking effect (2).

Paclitaxel (TAXOL; Bristol-Myers Squibb, Princeton, NJ), a new chemotherapy agent discovered by the National Cancer Institute screening program, is obtained from the bark of the Pacific yew (*Taxus brevifolia*) as well as the needles of some other yew species. Patients with metastatic breast cancer, advanced lung cancer, cancers of the head and neck, melanoma, ovarian cancer, and lymphomas have responded positively to Taxol (3).

American Indians use several native herbs for food and for medicinal purposes. Bee balm, black cohosh, elderberry, ginseng, goldenseal, mayapple, partridgeberry, ragweed, snakeroot, and yarrow are just a few of the herbs used by American Indians for healing (4). Self-prescribed herbal preparations are widely

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used today for a host of common ailments and conditions, such as anxiety, arthritis, colds, coughs, constipation, fever, headaches, infections, insomnia, intestinal disorders, premenstrual syndrome, stress, ulcers, and weakness. Some of the more popular herbs in use today include *Echinacea*, garlic, ginseng, goldenseal, ginkgo, saw palmetto, aloe vera, and feverfew. Research continues with respect to the usefulness of ginger for motion sickness; licorice for treating ulcers; hops, passionflower, and valerian for treating insomnia; feverfew for relieving migraine headaches; peppermint oil for relieving irritable bowel syndrome; saw palmetto berries for treating benign prostatic hypertrophy; *Echinacea* for its immunostimulant properties; St John's Wort (containing hypericin) for anxiety and depression; and milk thistle (with its rich content of flavono-lignans) for protecting and restoring liver function (5–7).

Culinary herbs have also been grown and used to flavor foods since antiquity. In most of these herbs, the flavor is provided by the aromatic ingredients in their essential oils and oleoresins. In addition, some herbs, ie, saffron, paprika, and turmeric, add color to food. Government agencies and some, but not all, health professionals recommend that for optimal health we should reduce our salt intake. This can be achieved by flavoring our meals to a greater degree with culinary herbs such as basil, caraway, cilantro, coriander, cumin, dill, oregano, rosemary, sage, thyme, and other herbal seasonings.

Whereas some herbal products may be safe and may contain active constituents that have beneficial physiologic effects, others may be unsafe to use. The Food and Drug Administration has classified several herbs as unsafe, even in small amounts, and hence they should not be used in either foods or beverages (8, 9). Some herbs are safe in modest amounts but they may become toxic at higher doses. For example, whereas licorice root can be used safely for treating duodenal and gastric ulcers, deaths from its excessive use have been reported. Large amounts of licorice can cause serious side effects such as hypokalemia, high blood pressure, and heart failure (10). Other herbs are known to be lethal. Germander, an herb used in some weight-loss programs, has been reported to cause fatal hepatitis (11). The Chinese herbs caowu and chuanwu are used to treat rheumatism, arthritis, bruises, and fractures. They may contain highly toxic alkaloids such as aconitine which produce neurologic, cardiovascular, and gastrointestinal disturbances. Use of these herbs can even result in death (12).

HERBS FOR CARDIOVASCULAR PROBLEMS

A plant-based diet that is rich in fruit, vegetables, and legumes and low in saturated fat, along with regular aerobic exercise program, is a typical prescription for anyone with elevated risk of cardiovascular disease. In addition, there are a few herbs available that provide some help for persons with either hyperlipidemia, an abnormal tendency to form blood clots, impaired blood flow, or other cardiovascular problems.

Some hypercholesterolemic patients have benefited from the use of psyllium (*Plantago psyllium*), a rich source of soluble fiber (10–12% mucilage) (2). When 5 g psyllium was given twice a day for 4 mo to subjects with blood cholesterol concentrations >5.7 mmol/L (220 mg/dL), their total- and LDL-cholesterol concentrations dropped an average of 0.26–0.39 and 0.28–0.34 mmol/L, respectively (10–15 and 11–13 mg/dL, respectively) (13). These changes tended to be greater in subjects consuming high-fat diets.

Garlic (*Allium sativum* L.) has been used effectively as food and medicine for many centuries. The compound that produces much of the activity of garlic is allicin, which is released when intact cells of a clove are cut or crushed. Allicin inhibits a wide variety of bacteria, molds, yeasts (including *Candida*), and viruses. Research has suggested that garlic protects against cardiovascular disease. Regular use of garlic can be effective in reducing the risk of heart attack and stroke because it lowers total- and LDL-cholesterol and triacylglycerol concentrations without affecting HDL-cholesterol concentrations (14, 15). Blood lipid concentrations are also favorably altered in normocholesterolemic subjects taking garlic (16). On average, one-half to one clove of garlic per day reduces hypercholesterolemia by ≈0.59 mmol/L (23 mg/dL) or ≈10% of the initial value (14). Garlic also increases fibrinolytic activity and inhibits platelet aggregation, in part because of the presence of ajoenes, allyl methyl trisulfide, vinyldithiins, and other sulfur compounds produced by the breakdown of allicin (15, 17–19). Researchers in Kuwait found that daily ingestion of 3 g garlic for 6 mo resulted in an 80% decrease in serum thromboxane B_2 and a 20% decrease in coronary heart disease in middle-aged men (20).

The odor-modified garlic extract (Kyolic; Maxpharma, Hojbjerg, Denmark) has been found to be just as effective as fresh garlic for lowering blood cholesterol concentrations (21). On the other hand, dried garlic is less effective than fresh garlic or is not active at all. The beneficial properties of garlic are typically seen when substantial amounts are used over a period of time. Onions (*Allium cepa* L.) may also be considered natural anticlotting agents because they possess substances that have fibrinolytic activity and can suppress platelet aggregation (15, 17, 22). A whole family of α-sulfinyl disulfides isolated from onions has been shown to strongly inhibit the arachidonic acid cascade in platelets (22).

Flour derived from flaxseed (*Linum usitatissimum*) is popular for use in bread and bakery products; it provides a nutty flavor and also increases the nutritional and health benefits of the final product. Flaxseed consumption may lower both total- and LDL-cholesterol concentrations because of its low–saturated fat content, high polyunsaturated fat and phytosterol content, and mucilage content (2, 23). When 15 patients with elevated blood cholesterol concentrations [>6.2 mmol/L (240 mg/dL)] consumed 15 g ground flaxseed and 3 slices of flaxseed-containing bread daily for 3 mo, their total- and LDL-cholesterol concentrations decreased by ≈10% and platelet aggregation decreased substantially, while their HDL-cholesterol and triacylglycerol concentrations did not change significantly (24).

Hypercholesterolemic subjects who consumed 140 mg/d of lemongrass (*Cymbopogon citratus*) oil, which is rich in geraniol and citral, experienced a drop in cholesterol concentrations over 3 mo (25). Other isoprenoids found in common herbs have been reported to suppress cholesterol concentrations (26). Studies of fenugreek (*Trigonella foenum-graecum*) have shown that it may also have hypocholesterolemic activity. Subjects with elevated blood cholesterol concentrations who consumed powdered fenugreek seeds experienced a significant reduction in LDL-cholesterol and triacylglycerol concentrations without any change in HDL-cholesterol concentrations (27, 28). Asian ginseng (*Panax ginseng*) is another medicinal plant with a long history of use. Researchers have discovered a nonsaponin fraction in ginseng root that inhibits platelet aggregation by potently inhibiting thromboxane A_2 production (29).

The oil in evening primrose (*Oenothera biennis*) seeds contains a significant amount (7–10%) of γ-linolenic acid (GLA) as

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well as high amounts (70%) of the more common α-linolenic acid (ALA). Interest in GLA centers around its ability to enter into prostaglandin synthesis more directly than does ALA. Some research groups have shown that evening primrose oil (EPO) may favorably alter blood lipid concentrations, decrease platelet adhesiveness, and increase blood clotting time (30–33). However, it appears that commercially available EPO is often contaminated with other, less expensive vegetable oils that may diminish or alter its activity.

A concentrated extract of the leaves of the Ginkgo tree has recently become a popular phytomedicine for improving cerebral blood flow. *Ginkgo biloba* extract appears to be somewhat effective, especially in geriatric patients, against conditions such as memory loss, dizziness, depression, confusion, and other ailments. These conditions often respond to the vasodilation and improved blood flow induced by Ginkgo extract. The active constituents in Ginkgo, which are thought to be flavone glycosides and diterpenoids (ginkgolides), inhibit the activity of the platelet activating factor (5, 34, 35).

Hawthorn is another herb used for improving blood flow. The leaves, fruit, and flowers of hawthorn (*Crataegus spp.*) are widely used in Europe for improving the pumping capacity of the heart and for treating angina. The major activity of hawthorn is thought to be provided by various flavonoids. Hawthorn causes dilation of the smooth muscles of the coronary vessels, thereby increasing blood flow and reducing the tendency for angina (5). French researchers have identified proanthocyanidins as active principles in the flower heads of hawthorn (*Crataegus oxyacantha*). These substances were reported to inhibit the biosynthesis of thromboxane A_2 (36). Patients with chronic heart disease who were given 600 mg/d of a hawthorn extract had lower blood pressure and heart rates and less shortness of breath when exercising compared with subjects not receiving hawthorn (37).

HEALTH-PROMOTING PROPERTIES OF FLAVONOIDS

Over 4000 flavonoids have been identified in plants (38). These universal plant pigments are responsible for the colors of flowers, fruit, and sometimes leaves (2). The commonly used herbs that provide substantial amounts of flavonoids include chamomile, dandelion, ginkgo, green tea, hawthorn, licorice, passionflower, milk thistle, onions, rosemary, sage, thyme, and yarrow. Flavonoids have extensive biological properties that promote human health and help reduce the risk of disease. Flavonoids extend the activity of vitamin C, act as antioxidants, protect LDL cholesterol from oxidation, inhibit platelet aggregation, and act as antiinflammatory and antitumor agents (39–41). The Zutphen study of elderly men in the Netherlands found that flavonoid intake from fruit, vegetables, and tea was inversely associated with heart disease mortality and incidence of heart attack and stroke over a 5-y period. Subjects who had the highest consumption of flavonoids had 60% lower mortality from heart disease and a 70% lower risk of stroke than those who consumed low amounts of flavonoids (42, 43). Data from the 16 cohorts participating in the Seven Countries Study revealed an inverse relation between the average flavonoid intake and age-adjusted mortality from heart disease after 25 y of follow-up (44).

Oxidative modification of LDL cholesterol is thought to play a key role during atherosclerosis. Plants contain a variety of antioxidants (including vitamins C and E and the carotenoids) that can inhibit oxidation of LDL cholesterol. Recently, licorice extract (free of glycyrrhizinic acid) and the isoflavan glabridin, a major polyphenolic compound found in licorice, were shown to markedly inhibit LDL oxidation via a mechanism involving scavenging of free radicals (45). LDL cholesterol isolated from 10 normolipidemic subjects who consumed 100 mg licorice extract/d for 2 wk was more resistant to oxidation than that isolated from the subjects before they consumed the licorice. During the study, total- and LDL-cholesterol concentrations and blood coagulation remained unchanged. When glabridin (20 μg/d) or the licorice extract was fed to atherosclerotic, apolipoprotein E–deficient mice, there was a significant reduction after 6 wk in the susceptibility of LDL cholesterol to oxidation and a reduction in the incidence and extent of atherosclerotic lesions in the aortic arch, compared with placebo-treated mice (45). The observation that glabridin was less active than whole licorice extract could be explained by the fact that licorice contains several other antioxidants including licochalcones and other polyphenols.

Several epidemiologic studies have suggested that drinking either green or black tea may lower blood cholesterol concentrations and blood pressure, thereby providing some protection against cardiovascular disease (46–48). When rats were fed green tea polyphenols, blood cholesterol concentrations declined in hypercholesterolemic animals and blood pressure decreased in spontaneously hypertensive animals (49). Some of these effects may be explained by the capacity of green tea catechins and gallate esters to reduce intestinal cholesterol absorption, lower blood coagulability, and inhibit proliferation of human aortic smooth muscle cells (49). Recently, LDL-cholesterol oxidation was inhibited by exposure to tea flavonoids, specifically the catechins from green tea leaves or theaflavins (catechin dimers) from black tea leaves (50). Of the catechins, epigallocatechin gallate provided the most protection and was more protective than vitamin E, whereas the theaflavins exerted even stronger inhibitory effects than the catechins.

A variety of phenolic compounds, in addition to the flavonoids, are found in fruit, vegetables, and many herbs. These phenolics influence the quality and stability of foods by acting as flavorants, colorants, and antioxidants. The phenolic compounds (such as caffeic, ellagic, and ferulic acids, sesamol, and vanillin) also exhibit anticarcinogenic activity and inhibit atherosclerosis (51). Many of the phenolic phytochemicals that have been shown to provide protection against heart disease and cancer are metabolites of the shikimic acid pathway (see **Figure 1**).

Anthocyanins are the water-soluble pigments responsible for the red, pink, mauve, purple, blue, and violet hues of many types of flowers and fruit. Hawthorn and juniper berries and rose hips are examples of herbs that contain anthocyanins. Because anthocyanins are effective in inhibiting LDL-cholesterol oxidation and platelet aggregation, these herbs may provide some protection against heart disease. Anthocyanins may also be useful for the treatment of vascular disorders and capillary fragility (2).

HELP FOR THE IMMUNE SYSTEM

Several herbal products that may enhance the function of the immune system are available. These include *Echinacea,* licorice, cat's claw, and garlic. Herbs that are rich in flavonoids, vitamin C, or the carotenoids may enhance immune function. The flavonoid-rich herbs may also possess mild antiinflammatory action (2, 5).

Echinacea (purple coneflower) is an herb with a long history of use. In the early 1900s it was the major plant-based antimi-

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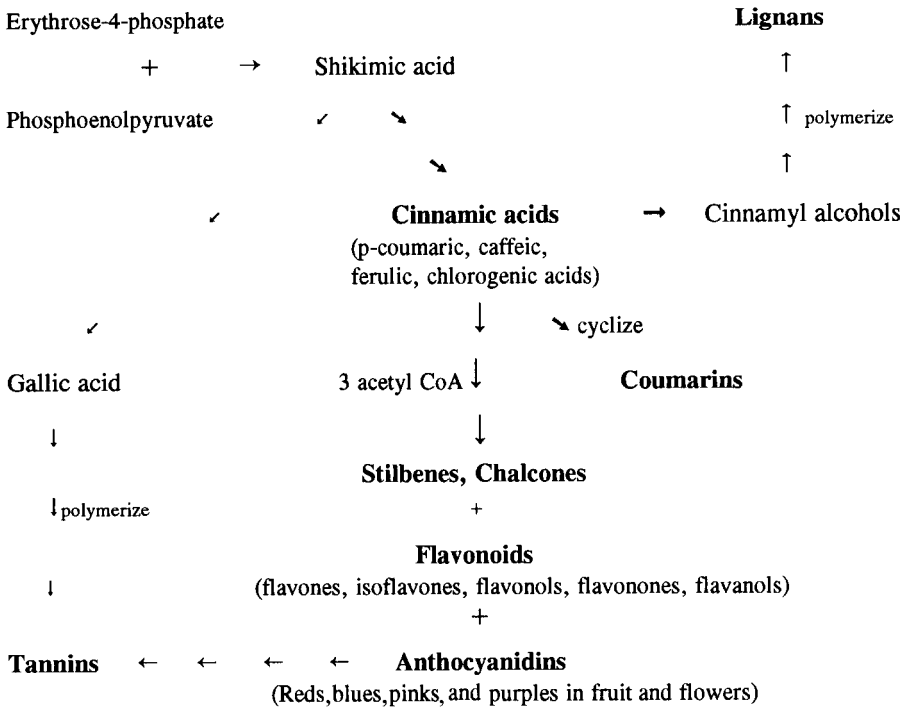

FIGURE 1. Shikimic acid metabolism.

crobial medicine in use. With the development of sulfa drugs, the use of *Echinacea* declined rapidly. Its beneficial effect in the treatment of infections results from its ability to act as an anti-inflammatory agent and as an immunostimulant. It can promote the activity of lymphocytes, increase phagocytosis, and induce interferon production (5). *Echinacea* appears to be useful in moderating the symptoms of the common cold, flu, and sore throat. It is thought that this activity is provided by certain polysaccharides, flavonoids, and isobutylamides (2).

Glycyrrhizin, a sweet-tasting triterpenoid saponin, is a major component of licorice root (*Glycyrrhiza glabra* L.). Glycyrrhizin and its aglycone, glycyrrhetinic acid, have been reported to induce interferon activity and augment natural killer cell activity (52). Hatano and colleagues (53) reported that the chalcones in licorice possess antiviral activity against HIV. Glycyrrhizin also has antiinflammatory and antiallergic properties (54).

Two species of cat's claw, *Uncaria guianesis* and *U. tomentosa*, which belong to the madder family (Rubiaceae), have been used for medicinal purposes by Peruvian Indians for over 2000 y. Both plants grow in the northern regions of South America and *U. tomentosa* also grows in Central America. Today, these plants are attracting much attention in the West because of their immunostimulant properties and potential to help fight AIDS and leukemia. European researchers have suggested that these plants enhance immune function because they contain various flavonoids, triterpenes, or alkaloids found in the root and stalk bark (55–57). Extracts of cat's claw have been reported to stimulate T cells, macrophages, and other components of the immune system. The plant extracts and fractions have also been reported to have antimutagenic and antiinflammatory properties (55, 56).

Garlic preparations have been found to exert an immunopotentiating effect by stimulating natural killer cell activity (58). In addition, 2 aromatic diones isolated from St John's Wort (*Hypericum perforatum* L.), hypericin and pseudohypericin, have been reported to have potent antiretroviral activity (2, 59). It was found that incubation of HIV with hypericin (a naphthodianthrone) rendered the virus noninfectious (60). St John's Wort may be useful for the treatment of HIV-infected patients because hypericin and pseudohypericin lack toxicity at therapeutic doses (59). St John's Wort and hypericin have also been used successfully for the treatment of depression (2).

HERBS WITH ANTICANCER ACTIVITY

Several commonly used herbs have been identified by the National Cancer Institute as possessing cancer-preventive properties. These herbs include members of the *Allium* sp. (garlic, onions, and chives); members of the Labiatae (mint) family (basil, mints, oregano, rosemary, sage, and thyme); members of the Zingiberaceae family (turmeric and ginger); licorice root; green tea; flax; members of the *Umbelliferae* (carrot) family (anise, caraway, celery, chervil, cilantro, coriander, cumin, dill, fennel, and parsley); and tarragon (61).

Researchers have identified a host of cancer chemoprotective phytochemicals in these herbs (**Table 1**). In addition, many herbs contain a variety of phytosterols, triterpenes, flavonoids, saponins, and carotenoids, which have been shown from studies of legumes, fruit, and vegetables to be cancer chemoprotective (72). These beneficial substances act as antioxidants and electrophile scavengers, stimulate the immune system, inhibit nitrosation and the formation of DNA adducts with carcinogens, inhibit hormonal actions and metabolic pathways associated with the development of cancer, and induce phase I or II detoxification enzymes (40, 61–64, 66, 67, 69, 72–76).

Several phytochemicals inhibit tumor formation by stimulating the protective phase II enzyme, glutathione transferase

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TABLE 1
Active phytochemicals found in herbs

Herbal source	Active phytochemicals
Allium sp. (garlic, onions, leeks, and chives)	Diallyl sulfide, disulfides, and trisulfides (62)
Labiatae family (basil, dill, fennel, marjoram, mint, rosemary, oregano, sage, thyme)	Monoterpenes, sesquiterpenes, and flavonoids (2, 62–65). Rosemary and sage contain diterpenoids (rosmanol, carnosol, carnosic acid, rosmarinic acid, epirosmanol, and isorosmanol), and ursolic acid (a triterpenoid) (66, 67)
Umbellifereae family (anise, caraway, celery seed, cilantro, coriander, cumin, dill, fennel, and parsley)	Coumarins, phthalides, polyacetylenes, and terpenoids (63, 64, 68)
Zingiberaceae family (turmeric and ginger)	Curcumin, gingerols, and diarylheptanoids (2, 63, 69)
Green tea	(−)-Epigallocatechin gallate and other catechins (63, 70, 71)
Licorice	Glycyrrhizin (a triterpenoid saponin) and chalcones (2, 54)
Flaxseed	Lignans (60)
Tarragon	Terpenoids (2)

(EC 2.5.1.18). GT is a detoxifying enzyme that catalyzes the reaction of glutathione with electrophiles to form compounds that are less toxic, more water-soluble, and can be excreted easily. Examples of phytochemicals that stimulate glutathione transferase activity include phthalides, found in umbelliferous herbs; sulfides, found in garlic and onions, curcumin in turmeric and ginger; and terpenoids, ie, limonene, geraniol, menthol, and carvone found in commonly used herbs (62, 72–74) (**Table 2**).

Research has shown that the terpenoids in plants increase tumor latency and decrease tumor multiplicity; terpenoids also elicit a significant reduction in total- and LDL-cholesterol concentrations, thereby reducing the risk of heart disease (77–82, 84–87). The different terpenoids in various herbs possess strong antioxidant activity (65). These terpenoids, which are responsible for the unique flavors of the herbs in the Labiatae and Umbellifereae families, are secondary metabolites derived from mevalonate metabolism (**Figure 2**). Because tumor cells synthesize and accumulate cholesterol faster than normal cells, the isoprenoids are useful cancer chemopreventive agents and suppress tumor growth by inhibiting HMG-CoA reductase (77, 81, 82, 84, 85, 88, 89). In fact, Elson (78) showed that isoprenoids inhibit tumor growth in direct proportion to their ability to inhibit the activity of HMG-CoA reductase. Isoprenoids may affect tumor growth without producing any change in blood lipid concentrations. For example, farnesol and geraniol, and to a lesser extent perillyl alcohol, substantially suppressed the growth of pancreatic tumor cells without significantly affecting blood cholesterol concentrations (87).

Garlic is known to have antitumor properties, owing to its content of a wide variety of organic sulfides and polysulfides. Garlic is reported to enhance immune function by stimulating lymphocytes and macrophages to destroy cancer cells; garlic is also reported to disrupt the metabolism of tumor cells. The inhibition of tumors by garlic seems to be most effective when the tumor is small. Various studies have shown that garlic can slow the development of bladder, skin, stomach, and colon cancers (21, 90–92). A prospective study of 42 000 Iowa women aged 55–69 y revealed that garlic consumption was inversely associated with cancer risk. Risk of cancer in the distal colon was 50% lower in women with the highest consumption of garlic than that of women who did not consume garlic (93). Garlic can inhibit the formation of nitrosamines, which are potent carcinogens, and can also inhibit the formation of DNA adducts (94).

Scientists at the National Cancer Institute have concluded from their collaborative studies with Chinese scientists that the occurrence of stomach cancer is inversely related with the consumption of garlic, onion, and other *Allium* species (95). In northern China, where garlic production is high, people have the lowest mortality from stomach cancer in all of China. Chinese people in the highest quartile of intake of garlic, onions, and other *Allium* herbs have a risk of stomach cancer that is 40% lower than that of people in the lowest quartile of intake (95).

In central Georgia, where Vidalia onions are grown, mortality rates from stomach cancer are about one-half the average US rates (72). Case-control studies in Greece have shown that high consumption of onions, garlic, and other *Allium* species. is protective against stomach cancer (72). A study in Dutch men and women aged 55–69 y revealed that the rate of cancer in the noncardia section of the stomach was ≈50% lower in those consuming the highest amount of onions (at least half an onion a day) compared with persons consuming no onions at all (96).

Flaxseed (*Linum usitatissimum*) contains a rich supply of lignans. These plant lignans are converted to mammalian lignans (enterolactone and enterodiol) by bacterial fermentation in the colon (97) and they can then act as estrogens. Mammalian lignans appear to be anticarcinogenic; lignan metabolites bear a structural similarity to estrogens and can bind to estrogen receptors and inhibit the growth of estrogen-stimulated breast cancer (98–100). Urinary excretion of lignans is reduced in women with breast cancer, whereas the consumption of flaxseed powder increases urinary concentration of lignans several-fold (101).

Turmeric (*Curcuma longa*) imparts a rich yellow color to food. Its active phenolic constituents inhibit cancer and also have antimutagenic activity. Turmeric has been shown to suppress the development of stomach, breast, lung, and skin tumors

TABLE 2
Terpenoids known to inhibit tumors[1]

Terpenoid	Herbs that contain the active terpenoid
Carvone	Caraway, spearmint, and dill
Cineole	Coriander, lavender, rosemary, sage, and thyme
Farnesol	Lemongrass, chamomile, and lavender
Geraniol	Lemongrass, coriander, melissa, basil, and rosemary
Limonene	Caraway, mints, cardamom, dill, celery seed, coriander, and fennel
Menthol	Peppermint
Perillyl alcohol	Lavender, spearmint, sage
α-Pinene	Caraway, coriander, fennel, juniper berry, rosemary, and thyme

[1] From references 2, 64, 76–83.

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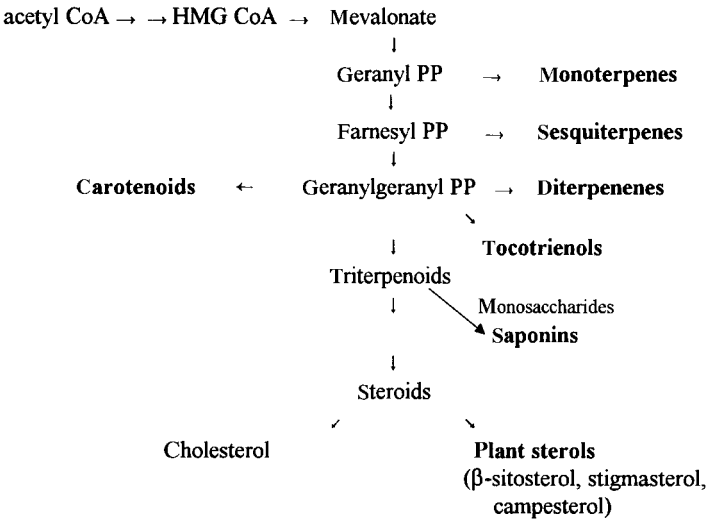

FIGURE 2. Overview of isoprenoid metabolism. HMG CoA, β-hydroxy-β -methylglutaryl coenzyme A; PP, pyrophospate.

(102, 103). Its activity is largely due to the antioxidant curcumin (a diferuloylmethane), which has been shown to be an effective antiinflammatory agent in humans (103). The rhizome of ginger contains curcumin in addition to a dozen phenolic compounds known as gingerols and diarylheptanoids. These compounds possess antioxidant activity that is even greater than that of α-tocopherol (69). Ginger also has antiemetic activity and is used to prevent motion sickness.

Carotenoids are the pigments found in green, leafy herbs; rose hips; and the herbs used as coloring agents, such as paprika, saffron, and annatto. The carotenoid pigments are effective antioxidants that quench free radicals, provide protection against oxidative damage to cells, and also stimulate immune function. Persons with high serum concentrations of carotenoids have reduced risk of both heart disease and cancer (104–106).

Polyphenolics in green tea (*Camellia sinensis*) are known to possess antimutagenic and anticancer activity. Some evidence suggests that tea has a protective effect against stomach and colon cancers (49). Animal studies also suggest that the risk of cancer in several organs is reduced by consumption of green and black tea or their principal catechins (49). The tumor incidence and average tumor yield in rats with chemically induced colon cancer were significantly reduced when the rats received (−)-epigallocatechin gallate, a major polyphenolic constituent of green tea (71). In a study conducted at the New Jersey Medical School, extracts of both black and green tea significantly inhibited leukemia and liver tumor cells from synthesizing DNA (107). Green and black tea are also reported to possess antifungal, antibacterial, and antiviral activity (49).

Korean studies suggest that ginseng (*Panax ginseng*) may lower the risk of cancer in humans (108). Ginseng extract and powder have been found to be more effective than fresh sliced ginseng, ginseng juice, or ginseng tea for reducing the risk of cancer (109). In a large-scale, case-control study in Korea, researchers observed that the incidence of human cancer decreased steadily with duration of ginseng use and total lifetime use of ginseng. Subjects who had taken ginseng for 1 y had a 36% lower incidence of cancer than nonusers, whereas those who had used ginseng for 5 y or more had a 69% lower incidence. Furthermore, those who had used ginseng <50 times during their lives had a 45% lower incidence of cancer, whereas those who had used ginseng >500 times in their lives had a 72% lower incidence (110). Ginseng seemed to be most protective against cancer of the ovaries, larynx, pancreas, esophagus, and stomach and less effective against breast, cervical, bladder, and thyroid cancers. The main active ingredients in ginseng root are thought to be a family of 6 triterpene saponins called ginsenosides (2). Other active constituents that may help reduce cancer risk include flavonoids, polysaccharides, and polyacetylenes (108).

Lentinan, a β-glucan found in shiitake mushrooms (*Lentinus edodes*), has been shown to have antitumor activity; it was active against lung carcinoma and 2 human melanomas (111). It is thought that lentinan has its effects by activating the host immune system. Lentinan stimulates increased production and activity of natural killer cells and macrophages, which destroy tumor cells (112). Preliminary studies also suggest that shiitake extracts possess hypolipidemic and antithrombotic activity (112). Screening tests on fungi belonging to the *Polyporaceae* family have identified several compounds with antitumor activity, including a variety of terpenoids and steroids, polysaccharides, and an organic germanium compound (113). Several other edible mushrooms are reported to have antitumor activity and other useful medicinal properties such as hypotensive action, antithrombotic activity, antiinflammatory effects, and ability to improve hyperlipidemia (114).

Phytomedicinals that have no proven value in the treatment of cancer are apricot pits (their laetrile content has no antitumor activity), pau d'arco (lapachol and its derivatives are actually toxic), and mistletoe (both the American and European mistletoes actually contain toxic polypeptides) (5).

CONCLUSION

A variety of herbs and herbal extracts contain different phytochemicals with biological activity that can provide therapeutic effects. Several herbs can help to reduce high blood cholesterol concentrations, provide some protection against cancer, and stim-

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ulate the immune system. Furthermore, a diet in which culinary herbs are used generously to flavor food provides a variety of active phytochemicals that promote health and protect against chronic diseases. Charlemagne was correct when he said "a herb is a friend of physicians and the praise of cooks" (115). The discriminate and proper use of some herbal products is safe and may provide some therapeutic benefits, but the indiscriminate or excessive use of herbs can be unsafe and even dangerous (5).

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