# CHAPTER 3

**Potential Nutraceutical Ingredients from Plant Origin**

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INTRODUCTION

Plants continue to be a major source of medicine, as they have been throughout human history. Plants are the only source of food and energy in our ecosystem. Food itself is a medicine. Food in our diet either enhances or disturbs the potency of the drug consumed. The human body consists of five elements: ether, water, air, fire, and earth. Every ancient medicine system, such as the Indian medicine system Ayurveda, the Chinese medicine Unani, and the Japanese healing system of Reiki, has described it in one way or another. The key to maintaining good physical and mental health is in keeping these five elements in harmonic balance through proper diet, herbs, and lifestyle; otherwise, early aging and various diseases can manifest. In light of the research in progress on the benefits of various phytochemicals in foods, it appears feasible that the naturally occurring chemical compounds in herbs could be helpful in the prevention or treatment of many chronic diseases, including cancer and cardiovascular disease. Although food has been used for a long time to improve...
health, around 400 BC, Hippocrates said, “Let your food be your medicine, and your medicine be your food.” Now, modern knowledge of health is being used to improve food. In recent years, scientific evidence has revealed that bioactive dietary components benefit health in ways that extend beyond meeting basic nutritional needs. The food and nutrition science has moved from simply identifying and correcting nutritional deficiencies to nutraceuticals, foods that promote optimal health and reduce the risk of certain debilitating diseases.

Around 80% of the world population is using herbs, plants, and other natural products as their first choice of medication for general illnesses. These natural plant products are not only used for primary healthcare in rural areas but in developing countries also, where modern medicines are predominantly used. Whereas the traditional medicines are derived from medicinal plants, minerals, and organic matter, the herbal drugs are prepared from medicinal plants. Natural products as disease remedies have a history of more than 5,000 years (India, China, and Greece). However, it is believed that pure compounds can only be the possible pharmaceutical drugs. Natural products are commonly rejected as drugs by regulatory health agencies because, most of the time, they are presented as crude extract mixtures with doubts about the reproducibility and standard of manufacturing.

Functional foods, nutraceuticals, pharmaco-nutrients, and dietary integrators are all terms used commonly for nutrients or nutrient-enriched foods that can prevent or treat diseases. The so-called “physiologically functional foods,” which originated in Japan in the 1980s, were defined as “any food or ingredient that has a positive impact on an individual’s health, physical performance, or state of mind, in addition to its nutritive value.” According to Dr. Stephen DeFelice, nutraceuticals are the “Food, or parts of food, that provide medical or health benefits, including the prevention and treatment of disease” [Kalra 2003]. Health Canada defines nutraceutical as “a product isolated or purified from foods, and generally sold in medicinal forms not usually associated with food and demonstrated to have a physiological benefit or provide protection against chronic disease” [Health Canada 2002].

This chapter is confined to the products associated with medicinal food or the medicinal products originated from the plants used by the global community. We have tried to incorporate the information about the plants, which are regularly used by the people as a remedy for their common illness all over the world. This is also a humble attempt to include the active nutraceuticals and ingredients present in the plants.

**SPICES AND SEASONINGS OF NUTRACEUTICAL VALUES**

Since time immemorial, Indians, Chinese, Japanese, Egyptians, and many other ancient cultures adopted several species as part of a regular diet. This food seasoning showed advantages in slowing the aging process, helping to prevent cancer (tumeric in colon cancer) and in helping with cardiovascular disease, Alzheimer’s disease (AD), diabetes, immune disorders, and obesity. Spices and flavoring plants rich in phytochemicals are receiving much attention as a possible source of cancer
Some of the compelling reasons as to why we should eat more spices include the following:

- Spices contain enormous quantities of extremely valuable disease-preventing phytochemicals. They contain multiple micronutrients and trace minerals required for physiological balance and activity of the human body and growth.
- Antioxidants, such as saffron, onion, garlic, and turmeric, all have multiple antioxidants in them. Individual spices, such as ginger, contain more than 25 antioxidants.
- Cancer rates in spice-consuming nations are up to 40 times lower than those of the United States and other western countries; turmeric, black pepper, cumin, caraway, cloves, ginger, anise, basil, chillies, fennel, mustard, rosemary, and garlic all contain potent anticancer compounds.
- Cardiovascular disease can be assisted with garlic, rosemary, cinnamon, coriander, fenugreek, ginger, oregano, mustard, and thyme, which protect against high cholesterol levels, “sticky platelets,” atherosclerosis, and high blood pressure.
- Diabetes care can include cinnamon and fenugreek, which can lower the blood glucose and cholesterol levels of diabetic patients by 25%.
- Aging spices slow the aging process by protecting DNA against oxidative damage and decay; garlic shows a promising role in skin care.

Food seasonings not only contains up-to-date scientific research into the healing properties of spices but also gives a fascinating account of the historical reasons why spices have become incorporated into the cuisines of different nations. It also explains why those people who eat large quantities of spices benefit from their health-promoting properties. In this part of the chapter, we are describing general spices mainly used in India for many years.

**Turmeric (Curcuma longa)**

*Curcuma longa* is a perennial herb and is a member of the Zingiberaceae (ginger) family. The plant grows to a height of three to five feet and is cultivated extensively in Asia, India, China, and other countries with a tropical climate. The parts used are the rhizomes, which are ovate, oblong, pyriform, or cylindrical and often short- branched. They are yellow to yellowish-brown in color. Turmeric has been used for centuries in Ayurvedic medicine as a treatment for inflammatory disorders, including arthritis. On the basis of this traditional usage, dietary supplements containing turmeric rhizome and turmeric extracts are also being used in the western world for arthritis treatment and prevention.

*Curcuma* is a rhizome used as a common food ingredient in Indian curries and as food ingredients in many South Asian countries. Curcumin is an important ingredient in that Curcuma has been reported to have antioxidant properties.

The chemical constituents are as follows: moisture, 13.1%; protein, 6.3%; fat, 5.1%; mineral matter, 3.5%; and carbohydrates, 69.4%. The essential oil (5.8%), obtainable by steam distillation of the rhizomes, has the following constituents: phellandrene, 1%; sabinene, 0.6%; cineol, 1%; borneol, 0.5%; zingiberene, 25%; and
sesquiterpenes, 53% [Kapoor 1990]. Curcumin (3–4%) is responsible for the yellow color. In addition, the monodemethoxy and bisdemethoxy derivatives of curcumin have been isolated from the rhizome [Vopel, Gaisbaure, and Winkler 1990].

Interest has greatly increased recently in the pharmaco-therapeutic potential of curcumin. In addition to its reported role in inhibiting tumorigenesis, metastasis, platelet aggregation, inflammatory cytokine production, oxidative processes, and myocardial infarction, curcumin has been shown to correct cystic fibrosis defects, lower cholesterol, suppress diabetes, enhance wound healing, modulate multiple sclerosis and AD, and block human immunodeficiency virus (HIV) replication. Furthermore, reports also support curcumin’s role in protecting against cataract formation, alcohol-induced liver injury, adriamycin-induced nephrotoxicity, drug-induced lung injury, and inflammatory bowel disease (IBD), and it has no apparent toxicity in extremely large oral doses (8 g/day) in humans [Okada et al. 2001; Egan et al. 2004]. Curcumin (1,7-bis[4-hydroxy-3-methoxyphenyl]-1,6-heptadiene-3,5-dione) is a naturally occurring plant product (major pigment in the Indian culinary spice turmeric) that acts as a natural nonsteroidal anti-inflammatory molecule. Curcumin has antioxidant, anti-inflammatory, and anticarcinogenic properties, scavenging reactive oxygen and nitrogen free radicals [Barik et al. 2007]. Previous work showed curcumin’s antioxidant role at various levels. Primarily, it has been shown to effectively scavenge free radicals and also inhibit the formation of proinflammatory cytokines. Curcumin has been shown to inhibit oxidation of oxidized LDL [Aggarwal, et al 2004]. Other data show that curcumin may be responsible for the lower incidence of colorectal cancer in Asian countries [Sharma, Bani, and Singh 1989].

Mustard (Brassica juncea)

There are several plant species in the genera Brassica and Sinapis, which belong to family Brassicaceae, whose small mustard seeds are used as a spice in India, China, and many parts of the world. It is a perennial herb, usually grown as an annual or biennial, up to 1 m or more tall; branches are long. Mild white mustard (Sinapis hirta) grows wild in North Africa, the Middle East, and Mediterranean Europe and has spread farther by long cultivation; brown or Indian mustard (B. juncea), originally from the foothills of the Himalaya, is grown commercially in the UK, Canada, and the US; black mustard (B. nigra) is grown commercially in Argentina, Chile, the US, and some European countries. Mustard is a nutritious food containing 28% to 36% protein. Its higher protein content is of particular interest when applied to processed meats. The vegetable oil of mustard is nutritionally similar to other oils and makes up 28% to 36% of the seed. Erucic acid is a significant component of mustard oil. Mustard oils are the characteristic flavor components of whole seed, ground mustard, and mustard flour (powder). The essential oil tocopherols present in mustard inhibits growth of certain yeasts, molds, and bacteria, enabling mustard to function as a natural preservative to help protect the oil from rancidity, thus contributing to a long shelf life. When mixed with water (or chewed), a chemical reaction occurs between an enzyme and a glucoside from the seeds, resulting in the production of the oil allyl isothiocyanate. Mustard is widely known for its sharp flavor. This
characteristic flavor is an essential component of many dressings and sauces worldwide. Unlike other “hot” flavors, the flavor profile of mustard does not linger. Rather, it presents itself quickly, dissipates, and leaves little or no after-taste. Mustard greens are extremely high in vitamin A, vitamin E, vitamin C, vitamin K and beta-carotene. They also contain vitamin B₆, folic acid, magnesium, calcium, iron, niacin and are an excellent source of phytochemicals thought to prevent cancer [Duke and Waine 1981]. An Indian variety of mustard (Brassica nigra), have been reported to be hypoglycaemic and helps in Diabetes mellitus [Srinivasan 2005].

Chili (Capsicum annum)

The chili pepper, or chili (C. annum), is the fruit of the plants from the genus Capsicum, which are members of the nightshade family, Solanaceae. The plant is an annual herb; leaves are alternate, simple, smooth margined; flowers are small, solitary, axillary, white, or greenish, 5-parted; fruit is a shiny, tapered berry of various colors.

The substance that gives chili peppers their intensity when ingested or applied topically is capsaicin (8-methyl-N-vanillyl-6-nonenamide) and several related chemicals, collectively called capsaicinoids. Capsaicin is the primary ingredient in pepper spray. When consumed, capsaicinoids bind with pain receptors in the mouth and throat that are normally responsible for sensing heat. Once activated by the capsaicinoids, these receptors send a message to the brain that the person has consumed something hot. The brain responds to the burning sensation by raising the heart rate, increasing perspiration, and releasing endorphins.

Red chilis contain high amounts of vitamin C and carotene. In addition, peppers are a good source of vitamin B₆. They are very high in potassium and high in magnesium and iron. Their high vitamin C content can also substantially increase the uptake of non-heme iron from other ingredients in a meal, such as beans and grains. The fruit of the C. annum is hot, pungent and is antihemorrhoidal when taken in small amounts. Furthermore, it is considered antirheumatic, antiseptic, diaphoretic, digestive, irritant, rubefacient, sialagogue, and tonic [Pradeep and Geervani 1994; Chiej 1984]. It is taken internally in the treatment of the cold stage of fevers, debility in convalescence or old age, varicose veins, asthma, and digestive problems [Bown 1995]. Externally, it is used in the treatment of sprains, unbroken chilblains, neuralgia, pleurisy, etc. It is an effective sea-sickness preventative [Chiej 1984].

Cumin (Cuminum cyminum)

Cumin is a small annual herb native to the Mediterranean region. Primary cultivation of cumin is in Europe, Asia, the Middle East, North Africa, and India. The seeds of Cuminum cyminum (family-Apiceae), commonly known as cumin, are used in food as a vegetable seasoning in India and in South Asian countries and as folk (herbal) medicine all over the world for the treatment and prevention of a number of diseases and conditions that include asthma, diarrhea, and dyslipidaemia.

C. cyminum is widely used in Ayurvedic medicine for the treatment of dyspepsia, diarrhea, and jaundice. Studies had been done to investigate the role of
C. cymimum supplementation on the plasma and tissue lipids in alloxan diabetic rats. Oral administration of C. cymimum for six weeks to diabetic rats resulted in significant reduction in blood glucose and an increase in total haemoglobin and glycosylated haemoglobin [Dhandapani et al. 2002]. It also prevented a decrease in body weight. C. cymimum treatment also resulted in a significant reduction in plasma and tissue cholesterol, phospholipids, free fatty acids, and triglycerides. In another study, the active component isolated from C. cymimum seeds against aldose reductase and b-glucosidase was identified as cuminaldehyde. The inhibitory responses varied with different concentrations. It has been reported that C. cymimum seed-derived materials have antimicrobial activity, a food spice, a fungicide, and a tyrosinase inhibitor [Boelens 1991]. It might be expected then that the active component isolated from C. cymimum seeds has a range of pharmacological actions for antidiabetic therapeutics. The pharmacological actions of the crude extracts of the seeds (and some of its active constituents, e.g. volatile oil and thymoquinone) that have been reported include protection against nephrotoxicity and hepatotoxicity, induced by either disease or chemicals. The seeds/oil have anti-inflammatory, analgesic, antipyretic, antimicrobial, and antineoplastic activity. The oil decreases blood pressure and increases respiration. Treatment of rats with the seed extract for up to 12 weeks has been reported to induce changes in the haemogram that include an increase in both the packed cell volume (PCV) and haemoglobin (Hb), and a decrease in plasma concentrations of cholesterol, triglycerides, and glucose.

The seeds contain both fixed and essential oils, proteins, alkaloids, and saponin. Much of the biological activity of the seeds has been shown to be attributable to thymoquinone, the major component of the essential oil, but which is also present in the fixed oil.

Fenugreek (Trigonella foenum-graecum)

The plant belongs to the family Fabaceae. It is commonly known as methi in India. It is an annual herb. The rhombic is frequently used in the preparation of Indian curries, paste, pickles, etc. The green and dried leaves of plant are also used as vegetable in several South Asian countries including India. Fenugreek may affect blood sugar levels by decreasing the activity of an enzyme that is involved in releasing stored sugar from the liver into the blood. Fenugreek seed contains only minute quantities of an essential oil. In the essential oil, 40 different compounds were found; furthermore, n-alkanes, sesquiterpenes, alkanoles, and lactones were reported. The dominant aroma component in fenugreek seeds is a hemiterpenoid b-lactone, sotolone (3-hydroxy-4,5-dimethyl-2(5H)-furanone). Also, fenugreek contains an amino acid called 4-hydroxyisoleucine, which appears to increase the body’s production of insulin when blood sugar levels are high [Saxena and Vikram 2004]. For many individuals, higher insulin production decreases the amounts of sugar that stay in the blood in some studies of animals and humans with both diabetes and high cholesterol levels. Fenugreek lowered cholesterol levels as well as blood sugar levels. However, no blood-sugar lowering effect was seen in nondiabetic animals. Similarly, individuals with normal cholesterol levels showed no significant reductions in cholesterol while
taking fenugreek. Double blind placebo controlled study in mild to moderate type 2 diabetes mellitus patients show adjunct use of fenugreek seeds improves glycemic control and decreases insulin resistance in mild type-2 diabetic patients. There is also a favorable effect on hyper-triglyceridemia [Gupta, Gupta, and Lal 2001].

**Black Cumin (Nigella sativa)**

In addition to black cumin, it is also called fennel flower, blackseed, black caraway, and Kalonji. It is an annual flowering plant, native to southwest Asia and belongs to the family Ranunculaceae. The fruit is a large and inflated capsule composed of 3–7 united follicles, each containing numerous seeds. *Nigella sativa* has a pungent aromatic taste with the seed used as a spice. Seeds have 0.5 to 1.4% of an essential oil and a saponin like glucoside, melanthin. Nigellone is also isolated from essential oils. The oil and seed constituents of *N. sativa*, in particular thymoquinine (TQ), have shown potential medicinal properties in traditional medicine. Oil also poses antioxidant effects via enhancing the oxidant scavenger system, which as a consequence lead to antitoxic effects. The oil and TQ have shown also potent anti-inflammatory effects on several inflammation-based models including experimental encephalomyelitis, colitis, peritonitis, oedema, and arthritis through suppression of the inflammatory mediators, prostaglandins and leukotriens. The oil and certain active ingredients showed beneficial immunomodulatory properties, augmenting the T cell- and natural killer cell-mediated immune response. Researchers at the Kimmel Cancer at Jefferson in Philadelphia have found that thymoquinone, an extract of nigella sativa seed oil, blocked pancreatic cancer cell growth and killed the cells by enhancing the process of programmed cell death. Although the studies are in the early stages, the findings suggest that thymoquinone could eventually have some use as a preventative strategy in patients who have gone through surgery and chemotherapy or in individuals who are at a high risk of developing cancer [Yi et al. 2008]. The pharmacological actions of the crude extracts of the *N. sativa* seeds that have been reported include protection against nephrotoxicity and hepatotoxicity induced by either disease or chemicals. The oil decreases blood pressure and increases respiration. It would appear that the beneficial effects of the use of the seeds and thymoquinone may be related to their cytoprotective and antioxidant actions, and also effect on some mediators of inflammation.

**Coriander (Coriandrum sativum)**

This soft annual herb belongs to the family Apiaceae. The shape of the leaves is variable, broadly lobed at the base of the plant, slender and feathery on the top. Its flowers are borne in small umbels and are white. The fruit is a small globular dry schizocarp. All parts of the plant are edible, but the fresh leaves and the dried seeds are the most commonly used in cooking.

From the water-soluble portion of the methanol extract of coriander, which has been used as a spice and medicine since antiquity, 33 compounds, including two new monoterpenoids, four new monoterpenoid glycosides, two new monoterpenoid
glucoside sulfates and two new aromatic compound glycosides were obtained [Ishikawa, Kondo, and Kitajima 2003]. By gas chromatography (GC) and GC-MS analysis, 64 compounds were isolated and revealed great qualitative and quantitative differences between the analyzed parts of coriander. In all organs, the main compound was (E)-2-dodecenal, followed by (E)-2-tridecenal, gamma-cadinene, (Z)-myroxide, neryl acetate, and eugenol [Msaada, et. al 2007]. Some of the nematocidal activity was found in coriander essential oil. Coriander has been documented as a traditional treatment for cholesterol and diabetes patients. Recently mechanism of some active compounds of coriander has been elucidated [Dhanapakiam et al. 2008].

**Fennel (Foeniculum vulgare)**

This hardy, highly aromatic, and flavorful perennial herb belongs to the family Apiaceae. Leaves are feathery, finely dissected and flowers are yellow on short pedicels. Fresh or dry leaves and dry grooved seeds are sweet and edible. Fennel is well known for its essential oil. Essential oils found in fennel have antimicrobial and alternative to larvicidal activity for mosquito [Schelz, Molnar, and Hohmann 2006; Pitasawat, et. al 2007]. Phenolic and total flavonoid content of wild fennel is higher than the cultivated ones and this aromatic plant has antioxidant activity. Different biologically active compounds like umbelliferone, forpsoralen, and foreugenol, etc. have been isolated from this plant [Dhalwal et al. 2007]. Ethanol extracts from fennel was found to be apoptotic on human leukaemia cell lines [Bogucka-Kocka, Smolarz, and Kocki 2008]. The aqueous extract of *Foeniculum vulgare* possesses significant oculohypotensive activity, which was found to be comparable to that of timolol. Additional investigations into the mechanism of action, possible toxicity, and human clinical trials are warranted before the *Foeniculum vulgare* finds place in the arsenal of antiglaucoma drugs prescribed by physicians. The activation of nuclear transcription factor κB (NF-κB) has now been linked with a variety of inflammatory diseases, including cancer, atherosclerosis, myocardial infarction, diabetes, allergy, asthma, arthritis, Crohn’s disease, multiple sclerosis, AD, osteoporosis, psoriasis, septic shock, and AIDS. Anethol, a phytochemicals found in this plant can suppress NF-κB [Aggarwal and Shishodia 2004].

**Asafoetida (Ferula assa-foetida)**

It is usually abbreviated to Asafoetida, and it originates in Persia and Afghanistan. It belongs to the Apiaceae family of plants, and is related to Parsley. This plant grows wild in Kashmir (India), Iran, and Afghanistan. It has an unpleasant smell, is herbaceous and perennial, and grows up to 2 m high. The part used is an oleogum resin, obtained by incision from the root, and called asa-foetida. It is extremely sulphur-rich and is very beneficial as a de-toxicating agent. Even more effective than garlic, it is used in very small quantities only a pinch being required. It is also credited with being an antiflatulent. Glucuronic acid, galactose, arabinose and rhamnose have been isolated from the gum [Kapoor 1990]. Taste and smell are attributable
to sulfur-containing compounds. Disulfides as well as symmetric tri- and tetrasulfides have been isolated [Rajanikanth, Ravindranath, and Shankaranarayana 1984]. Umbelliferone, the farnesiferoles A, B, and C, ferulic acid, and the cumarin derivatives foetidin and kamolonol are also present [Caglioti et al. 1958; Caglioti et al. 1959; Hofer, Widhalm, and Greger 1984]. Multiple studies elicited and identified sesquiterpenes from the roots of Asafoetida. They are phenylpropanoid derivatives, coumarin derivatives or chromone derivatives. These sesquiterpene derivatives inhibits nitric oxide (NO) production and inducible NO synthase (iNOS) gene expression [Motai and Kitanaka 2005]. Inhibition of NO production has multiple implications in human disease development especially in respiratory and cardiovascular diseases.

In Nepal asa-foetida is considered to be sedative, carminative, antispasmodic, diuretic, anthelmintic, and emmenagogue, as well as an expectorant. It is an aphrodisiac, and increases the sexual appetite [Eigner and Scholz 1990]. Daily dose is around 0.2–0.5g.

Asa-foetida has not been studied much. It produces slight inhibition of the growth of Staphylococcus aureus and Shigella sonnei, and some of the sulfur compounds show pesticidal activity. Higher doses taken orally cause diarrhoea, meteorism, headaches, dizziness, and enhanced libido [Kapoor 1990].

Garlic (Allium sativum)

Garlic is a small herb that belongs to the family Liliaceae. It is believed to thin the blood, reduce cholesterol, decrease blood pressure, inhibit atherosclerosis, and improve circulation. Epidemiologic studies show an inverse correlation between garlic consumption and progression of cardiovascular disease. Multiple in vitro studies have confirmed the ability of garlic to reduce cardiovascular risk factors, such as total cholesterol, raised low-density lipoprotein (LDL) and LDL oxidation, reduced platelet aggregation, and hypertension. Several studies have indicated that garlic and its constituents inhibit key enzymes involved in cholesterol and fatty acid synthesis [Nies et al. 1984; Sovová and Sova 2004]. Randomized clinical trials have been conducted for antihypertensive, anti-atherosclerotic, and antiplatelet actions, and intermittent claudication. A recent summary of the data supporting garlic’s potential in modifying cardiovascular risk, although generally supporting its usefulness, also emphasized the lack of knowledge about active compounds and mechanisms of action. Although garlic is believed to be beneficial for conditions for which approved drugs are available, such as hyperlipidemia and hypertension [Tattelman 2005; Knox and Gaster 2007], few studies compare it with pharmacologic treatments. The active substance is allicin, formed by the action of alliinase on alliin when garlic is crushed. Alliinase is inactivated by acid pH, heat, and extraction in organic solvents [Agarwal 1996]. Thus, garlic’s effects are dependent on whether it is cooked or in aqueous, oil, or organic extracts. In addition to allicin, other active compounds in garlic include methyl allyl trisulfide, diallyltrisulfide, diallyl disulfide, and ajoene. Its characteristic odor is associated with the active compounds, which limits blinding in clinical trials. Few trials indicate whether placebo could be differentiated from active treatment. Garlic is generally
safe and well tolerated; however, serious adverse events, including central nervous system (CNS) bleeding and skin burns from topical application, have been reported [Bent 2008]. Effects such as flatulence, dyspepsia, allergic dermatitis, and asthma have been described in literature. Increases in both the prothrombin time and international normalized ratio in subjects previously stable on warfarin have been attributed to garlic; however, there is little to substantiate the mechanism of the interaction.

**Ginger (Zingiber officinale)**

The common cooking ginger is an herbaceous perennial plant that belongs to the family Zingiberaceae. Ginger grows from an aromatic tuberlike rhizome, which is warty and branched. Dried ginger powder, 500–1,000 g, or fresh ginger, 2–4 m, is used for nausea. Ginger’s alleged vitalizing effect on the heart and blood is attributed to decreased platelet aggregation and inhibition of thromboxane synthesis observed in *in vitro* studies [Chrubasik, Püttler, and Roufogalis 2005]. Clinical studies, however, using raw, cooked, or dried ginger do not show an effect on bleeding time, platelet aggregation, or thromboxane production. There is supportive evidence from one randomized controlled trial and an open-label study that ginger reduces the severity and duration of chemotherapy-induced nausea/emesis. Compounds isolated from ginger, including shogaol and gingerol, have been studied for positive inotropic and pressor effects; however, no clinical trials currently support these effects. Neither adverse effects nor drug interactions have been reported. The anti-inflammatory properties of ginger have been known for centuries. During the past years, many laboratories have provided scientific support for the long-held belief that ginger contains constituents with anti-inflammatory properties. *In vitro* ginger inhibits all the inflammatory markers of osteoarthritis, for example, ginger suppresses prostaglandin synthesis through inhibition of cyclooxygenase-1 [COX1] and COX2 [Grzanna, Lindmark, and Frondoza et al. 2005; Pan et al. 2008]. Evaluation of the effect of a ginger extract on patients suffering from gonarthrosis shows the effectiveness of the ginger. Ginger extract was as effective as placebo during the first three months of the study, but, at the end of six months, the ginger extract group showed a significant superiority over the placebo group [Wigler et al. 2003]. The main pharmacological actions of ginger and compounds isolated from them include immunomodulatory, antitumorigenic, anti-inflammatory, antiapoptotic, antihyperglycemic, antilipidemic, and antiemetic actions. Ginger is a strong antioxidant substance and may either mitigate or prevent generation of free radicals [Ali et al. 2008].

**Onion (Allium cepa)**

*Allium cepa* is the common onion usually used as a vegetable and belonging to the Alliaceae family. Onions are perennials that are cultivated for food worldwide. There are many varieties. Most onion bulbs are white, yellow, or red. The green stems and leaves are hollow and can reach 3 feet (1 m) in height. The plants bear small flowers that are usually white or purple. The fleshy bulb that grows below the ground is used medicinally as well as for food.
Multiple studies have suggested that dietary flavonoids are helpful in the prevention of atherosclerosis and cardiovascular disease. Antioxidant properties of flavonoids are suggested as a mechanism for its effect on cardiovascular diseases [Terao, Kawai, and Murato 2008]. Onion contains several flavonoids, including quercetin (3,3’,4’,5,7-pentahydroxyflavone), a major flavonoid in onion [Murota et al. 2007]. Quercetin metabolites are detected in human atherosclerotic plaques and act as complementary antioxidants, when oxidative stress is loaded in the vascular system [Augusti 1996]. Onion contain many sulfur-containing active principles mainly in the form of cysteine derivatives; these get decomposed into a variety of thiosulfonates and polysulfides by the action of an enzyme alliinase. Decomposed products are volatile and present in the oils of onion and garlic. They possess antidiabetic, antibiotic, hypocholesterolaemic, fibrinolytic, and various other biological actions. In addition to free sulfoxides in onion, there are nonvolatile sulfur-containing peptides and proteins, which possess various activities and thus make these vegetables an important source of therapeutic agents [Augusti 1996].

**Clove (Syzygium aromaticum or Eugenia caryophyllata)**

It is the aromatic dried flower buds of a tree in the family Myrtaceae. Cloves are native to Indonesia and India and are used as a spice in cuisine all over the world. A small- to moderate-sized evergreen tree grows up to 15 m of height. Leaves are simple, lanceolate, and fragrant; flower buds are pink, found as clusters in the tip of branches, aromatic, and have pungent taste. Fruits are fleshy dark drupes, enclosing oblong grooved seeds. The essential oil extracted from the dried flower buds of clove is used as a topical application to relieve pain and to promote healing and also finds use in the fragrance and flavoring industries. The main constituents of the essential oil are phenylpropanoids, such as carvacrol, thymol, eugenol, and cinnamaldehyde. The biological activity of plant has been investigated on several microorganisms and parasites, including pathogenic bacteria, *Herpes simplex*, and hepatitis C viruses. In addition to its antimicrobial, antioxidant, antifungal, and antiviral activity, clove essential oil possesses anti-inflammatory, cytotoxic, insect repellent, and anesthetic properties.

One scientific study reported an effect on lung carcinoma cells. Infusion of aqueous clove solution can elicit strong proapoptotic effect during early lesion of lung carcinogenesis and can also affect the *in situ* cell proliferation [Banerjee, Panda, and Das 2006]. Serious studies on the effect of clove on human lung carcinomas are still lacking.

**Nutmeg (Myristica fragrans)**

Nutmegs are a genus of aromatic evergreen trees and belong to the Myristicaceae family, indigenous to tropical Southeast Asia and Australia. The extracts of *Myristica fragrans* can be useful in the treatment of human diarrhea if the etiologic agent is a rotavirus [Gonçalves et al. 2005]. Myristicin, or methoxysafrole, is the principal aromatic constituent of the volatile oil of nutmeg, the dried ripe seed of *M. fragrans*.
Large doses of 60 g or more are dangerous, potentially inducing convulsions, palpitations, nausea, eventual dehydration, and generalized body pain [Demetriades et al. 2005]. In amounts of 10–40 g, it is a mild to medium hallucinogen, producing visual distortions and a mild euphoria.

**Bay Leaf (Laurus nobilis)**

It is the aromatic leaf of several species of the Laurel family (Lauraceae). The leaf of the *Cinnamomum* tree (Indian Tejpatra) is similar in fragrance and taste to cinnamon bark. Bay leaves are a major component of Indian spices used for seasoning the vegetables and curries have a pungent and sharp, bitter taste. *Laurus nobilis* fruit contains essential oils and has high anticancerous activity. Study suggests that the ability of *L. nobilis* essential oils and some identified terpenes to inhibit human tumor cell growth. *L. nobilis* plant also contains the sesquiterpene lactones 5a,9-dimethyl-3-methylene-3,3a,4,5,5a,6,7,8-octahydro-1-oxacyclopenta[ c]azulen-2-one and 3β-chlorodehydrocostuslactone isolated by the chromatographic separations on active extracts from fruits and leaves of the plant [Dall’Acqua et al. 2006]. The isolated compounds were found to inhibit NO production. Methanolic extract from plant leaves and bark inhibits the lipid peroxidation. The cytotoxic activity was also evaluated against three different tumor cell lines of human origin and found to be effective in killing the carcinogenic cells.

**Cardamom (Elettaria cardamomum)**

Cardamom is a pungent aromatic herbaceous perennial plant growing to 2–4 m in height and belonging to the family Zingiberaceae. The fruit is a three-sided yellow-green pod 1–2 cm long, containing several black seeds. The black seeds from the pods of the plant are dried and are used in Indian and other Asian cuisines either whole or in a ground form.

In many parts of the world, including Indian and China, cardamom is traditionally used to treat stomachaches, constipation, dysentery, and other digestion problems. The administration of cardamom extract to Chinese hamsters increased fecal moisture contents (148–174%), decreased the activities of β-D-glucuronidase, β-D-glucosidase, mucinase, and urease in feces, and reduced the production of toxic ammonia [Huang et al. 2007]. These findings suggested that the consumption of cardamom extract might exert a favorable effect on improving the gastrointestinal milieu and may help in digestion.

**Cinnamon (Cinnamomum verum; synonym Cinnamomum zeylanicum)**

Cinnamon is a small evergreen tree 10–15 m (32.8–49.2 feet) tall, belonging to the family Lauraceae, and is native to Sri Lanka, India, Bangladesh, and Nepal. The bark is widely used as a spice because of its distinct odor. Young branches of tree are dark brown, terete, and glabrous.
Its flavor is attributable to an aromatic essential oil that makes up 0.5–1% of its composition. Chemical components of the essential oil include ethyl cinnamate, eugenol, cinnamaldehyde, β-caryophyllene, linalool, and methyl chavicol.

Several pharmacological studies suggest the antioxidant properties of the bark from plant; seven clinical trials suggest strong evidence for the effect of cinnamon on type 2 diabetes. Two of the randomized clinical trials on type 2 diabetes provided strong scientific evidence that cinnamon demonstrates a therapeutic effect in reducing fasting blood glucose by 10.3–29% [Verspohl 2005]. Study on patients by Khan et al. [2003] demonstrates effects of low levels (1–6 g/day) of cinnamon on the reduction of glucose, triglyceride, LDL cholesterol, and total cholesterol levels in subjects with type 2 diabetes, but in other studies, cinnamon does not appear to improve glycated hemoglobin, fasting blood glucose, or lipid parameters in patients with type 1 or type 2 diabetes [Baker et al. 2008].

**Saffron (Crocus sativus)**

Saffron (Crocus sativus) is a spice derived from the flower of the saffron crocus, a species of crocus in the family Iridaceae. The true saffron is a low ornamental plant with grass-like leaves and large lily-shaped flowers. The flower has three stigmas, which are the distal ends of the plant’s carpels. Together with its style, the stalk connecting the stigmas to the rest of the plant, these components are often dried and used in cooking as a seasoning and coloring agent. The chemical composition of saffron has attracted the interest of several research groups during the past decades and, among the estimated 150 volatile and several nonvolatile compounds of saffron, some of them have been identified [Winterhalter and Staubinger 2000]. Saffron contains three main pharmacologically active metabolites. (1) Saffron-colored compounds are crocins, which are unusual water-soluble carotenoids. These are mono and diglycosyl esters of a polyene dicarboxylic acid, named crocetin. The digentiobiosyl ester of crocetin, -crocin, is the major component of saffron. (2) Picrocrocin is the main substance responsible of the bitter taste in saffron. (3) Safranal is the volatile oil responsible for the characteristic saffron odor and aroma. Furthermore, saffron contains proteins, sugars, vitamins, flavonoids, amino acids, mineral matter, gums, and other chemical compounds [Rios 1996]. C. sativus extract and its major constituent, crocin, significantly inhibited the growth of colorectal cancer cells but did not affect normal cells [Aung et al. 2007]. Recent scientific findings have been encouraging, uniformly showing that saffron and its components can affect carcinogenesis, and currently have been studied extensively as the most promising cancer chemopreventive agents. Extracts from saffron, the dried stigmata from C. sativus, are being used more frequently in preclinical and clinical trials for the treatment of cancer and depression. Series of clinical trials on saffron on depressed out-patients show a significant improvement in signs of depression. In a double-blind and randomized trial, patients were randomly assigned to receive capsule of petal of C. sativus at 15 mg (Group 1) and fluoxetine at 10 mg (two times per day (Group 2) for an eight-week study. At the end of trial, a petal of C. sativus was found to be effective in the treatment of mild to moderate depression, similar to fluoxetine [Akhondzadeh
et al. 2007]. Double-blind trials and placebo-controlled trials were done to investigate whether saffron could relieve symptoms of premenstrual syndrome (PMS). The results of this study indicate the efficacy of *C. sativus* in the treatment of PMS. However, a tolerable adverse effects profile of saffron may well confirm the application of saffron as an alternative treatment for PMS. Promising and selective anticancer effects have been observed *in vitro* and *in vivo* but not yet in clinical trials. Antidepressant effects were found *in vitro* and in clinical pilot studies. Saffron extracts thus have the potential to make a major contribution to rational phytotherapy [Schmidt, Betti, and Hensel 2007].

**NUTRACEUTICALS FROM FRUITS AND VEGETABLES**

**Mango (*Mangifera indica*)**

The mango tree is erect, 30–100 feet (roughly 10–30 m) tall, with a broad, rounded canopy, and belongs to the family Anacardiaceae. It is nearly evergreen. Its fruit is aromatic, varies in size and shape, is usually round, oval, ovoid-oblong, or somewhat kidney shaped, often with a break at the apex.

Mango fruit is rich in antioxidants. Mangiferin is an antioxidant present in the ripened fruit, which prevents the lipid peroxidation by decreasing the $O_2$ concentration, blocks reactive oxygen species production, binds metal ions such as Fe$^{3+}$ and Fe$^{2+}$, and prevents the generation of hydroxyl radicals [Ghosal 1996]. Mango fruit also contains cycloartenol, 3β-hydroxycycloart-24-en-26-al, 24-methylene-cycloartan-3β,26-diol, C-24 epimers of cycloart-25-en-3β,24-diol, α-amyrin, β-amyrin, dammarenediol II, β-taraxastane-3β, 20-diol, octotillol, methyl mangiferonate, methyl mangiferol, methyl isomangiferolate, sitosterol, a mixture of 5-(12-cis-heptadecenyl)- and 5-pentadecyl-resorcinols, and vitamins A and C [Rastogi and Mehrotra 1995]. Unripe fruits of mango contain polysaccharides, a triterpene, acetates of cycloartanol, amyrin, lupeol, and homomangiferin-2C-glucopyranosyl-3-methoxy-1,6,7-trihydroxyxanthone. Mango stem bark contains protocatechuic acid, catechin, mangiferin, alanine, glycine, aminobutyric acid, kinic acid, shikimic acid, tetracyclic triterpenoids, cycloart-24-en-3β,26-diol, 3-ketodammar-24(E)-en-20S,26-diol, C-24 epimers of cycloart-25-en-3β,24,27-triol, and cycloartan-3β,24,27-triol. Mango bark has been traditionally used in many countries for the treatment of menorrhagia, diarrhea, syphilis, diabetes, scabies, cutaneous infections, and anaemia, using an aqueous extract obtained by decoction as reported in the NAPRALERT database. The use of mango stem bark extract (MSBE) has been documented on more than 7,000 patients with emphasis on patients with malignant tumors [Tamayo et al. 2001]. *In vitro* tests demonstrated that MSBE had no cytotoxic effects on tumor cells. However, more than 95% of cancer patients treated with MSBE (2,286 patients) evidenced an improvement in terms of their quality of life (appetite, body weight, self-independence for the daily life, etc.); inflammation and/or pain were significantly reduced, and several biochemical markers were improved with time (i.e., haemoglobin and transaminase, being the most significant) [Nunez-Selles et al. 2002]. It was relevant that more than
60% of patients with diabetes mellitus (408 patients) reduced the insulin dose by 20 IU after six months of MSBE oral administration [Padin et al. 2005], 80% of patients with benign prostate hyperplasia (826 patients) improved the urine retention after three months of MSBE administration (oral and rectal), and 95% of patients with different types of dermatitis (1,297 patients) were improved after one-week treatment with topical MSBE. Also significant was that 87% of patients with Lupus erythematosus (675 patients) improved their quality of life after the first month of MSBE treatment (oral and topical administration). Mangiferin is a C-glucosylxanthone, and it has cardiotonic and diuretic properties. Gallic acid and quercetin show a strong antiviral activity. Mangiferin stimulates after 48 h the proliferation of thymocytes and spleenic lymphocytes, with a peak response at 5.0 g/ml and 20.0 μg/ml, respectively [Rastogi and Mehrotra 1993].

**Apple (Malus domestica)**

This cultivated fruit tree belongs to the rose family Rosaceae. The tree is small and deciduous with a broad, often densely twiggy crown. The leaves are simple ovals, alternatively arranged with serrated margins. The flowers are pinkish-white with five petals. The center of the pomaceous fruit contains five carpels arranged in a five-point star, each containing one to three seeds. Apples contain a rich source of both nutrient and non-nutrient components and contain high levels of polyphenols and other phytochemicals. Main phytochemicals include hydroxycinnamnic acids, dihydrochalcones, flavonols (quercetin glycosides), catechins and oligomeric procyanidins, as well as triterpenoids in apple peel and anthocyanins in red apples [Gerhauser 2008]. Apple peels have high concentrations of phenolic compounds and may assist in the prevention of chronic diseases. Very recently, He and Liu [2008] isolated 29 phytochemicals from apples skin. They have shown that two compounds (i.e., quercetin and quercetin-3-O-β-d-glucopyranoside) showed potent antiproliferative activities against HepG2 and MCF-7 cells, whereas six flavonoids and three phenolic compounds showed potent antioxidant activities. Davis et al. [2006] suggested that flavonoids in apple extract downregulates nuclear factor-κB signaling and thereby shows antioxidant effects. Therefore, greater intake of apple contributes to improved health by reducing the risk of diseases, such as cardiovascular disease and some forms of cancer (i.e., colon, prostate, and lung).

**Grapes (Vitis vinifera)**

This perennial, deciduous woody vine with a flaky bark belongs to the family Vitaceae. Most of them are cultivars of *Vitis vinifera*. The leaves are alternate and palmately lobed. The fruit is a berry. Different phytochemicals, such as polyphenols (stilbenes and anthocyanins), condensed tannins (proanthocyanidins), tetrahydro-β-carbolines, dietary indoleamines, melatonin, and serotonin, have been described in grapes [Iriti and Faoro 2006]. Resveratrol, a stilbene-type aromatic phytoalexin predominantly found in grapes, exhibit several physiological activities, including anticancer and anti-inflammatory activities in vitro and in experimental animal...
models, as well as in humans [Udenigwe et al. 2008]. Resveratrol displayed significant antiproliferative effects \textit{in vitro} on cultured human colon cancer cells [Duessel, Heuertz, and Exekiel 2008]. Anthocyanins, a flavonoid found profusely in grapes, has breast cancer chemopreventive potential attributable in part to their capacity to block carcinogen-DNA adduct formation [Singleton, Jung, and Giusti 2007]. Numerous phytonutrients found in grapes are also beneficial for AD and urinary bladder dysfunction.

\textbf{Bilwa or Bel (Aegle marmelos)}

It is a small- to medium-sized aromatic tree, the average height of which is 8.5 m, is deciduous, and belongs to the family Rutaceae.

The bilwa tree is one of the most useful medicinal plants of India and in many parts of South-East Asia. Its medicinal properties have been described in the ancient medical treatise in Sanskrit, \textit{Charaka Samhita}. All parts of this tree, including the stem, bark, root, leaves, and fruit, have medicinal values and have been used as medicine for a long time. A series of phenylethyl cinnamides, which included new compounds named anhydromarmeline, aegelinosides A and B, has been identified in leaves of \textit{Aegle marmelos}, which is an \(\alpha\)-glucosidase inhibitor [Phuwapraisirisan et al. 2008]. The leaves and fruits of the tree are used in ethanopharmacological drugs for type 2 diabetes. Recent investigations have reported the exceptional actions of \(\alpha\)-glucosidase inhibitors from natural sources. A hydroxyl amide alkaloid from \textit{A. marmelos} leaves is reported to suppres both blood glucose and plasma triglyceride levels [Narender et al. 2007]. Many other uses of bel fruits are reported; for instance, the ripe fruit are regarded as a very good laxative. The unripe or half-ripe fruit is perhaps the most effective remedy for chronic diarrhea and dysentery. An infusion of bel leaves is regarded as an effective remedy for peptic ulcer. The fruit, leaves, and bark of the tree is considered as remedy for multiple illnesses. Extensive research is required to use them on a larger scale.

\textbf{Awala (Phyllanthus emblica)}

This large deciduous tree belongs to the family Euphorbiaceae. Fruit are loaded with different bioactive compounds, such as phyllamin, phyllemblic acid, gallic acid, embcol, ellagic acid [Nizamuddin, Hoffman, and Olle 1982], SOD482 [Fengshu et al. 1992], putranjivain A [El-Mekkawy et al. 1995], emblicanin A and B, punigluconin, and pedunculagin [Ghosal 1996]. The fruit of \textit{Phyllanthus emblica} is used as a powerful rejuvenator in Ayurvedic medicine and is one of the major ingredients of chavanprash (a herbal tonic in Ayurvedic medicine). The chondroprotective potentials of this fruit were reported by Sumantran et al. [2008]. Amla fruit extract works effectively in mitigative, therapeutic, and cosmetic applications through control of collagen metabolism, and it also protect the skin from the damaging effects of free radicals, nonradicals, and transition metal-induced oxidative stress [Fujii et al. 2008].

The fruit was found to contain pyrogallol, an active compound responsible for the anti-inflammatory effect in bronchial epithelial cells. Antioxidant-enriched amla is
very useful for oxidative stress-related diseases and may prevent age-related hyperlipidaemia through attenuating oxidative stress in the aging process [Yokozawa et al. 2007]. Superoxide scavenging potential has been proven for this fruit extracts [Saito et al. 2008]. Multiple animal studies showed that the dried fruit powder of *P. emblica* is hypolipidemic and induced partial regression of atherosclerotic lesions in arteries and decreased lipogenesis.

The tannoid principles of the fruits of the plant *P. emblica*, including emblicanin A, emblicanin B, punigluconin, and pedunculagin, have been reported to exhibit antioxidant activity *in vitro* and *in vivo* and supports its use in Ayurveda as hepatoprotectant [Bhattacharya et al. 2000].

**Banana (Musa paradisiaca)**

This herbaceous, tall, upright, fairly sturdy plant belongs to the family Musaceae, cultivated mainly for its fruit. Its upright stem is a pseudo stem with big leaves of several meters in length. Each pseudo stem produces a bunch of banana, which grows in hanging clusters. Bananas are rich in vitamin B₆, vitamin C, and potassium. The potassium content of one medium banana is equivalent to a 12 mmol potassium salt tablet [Hainsworth and Gatenby 2008] and is thus recommended for cardiac health. The antioxidant activity of banana flavonoids has been described previously [Vijayakumar, Presannakumar, and Vijayalakshmi 2008]. One of the varieties of banana *M. sapientum* has antidiabetic activity, which may be attributable to the presence of flavonoids, alkaloids, steroid, and glycoside compounds [Dhanabal et al. 2005].

**Broccoli (Brassica oleracea)**

This plant belongs to the family Brassicaceae. Fleasy green flowerheads are edible and surrounded by leaves. It is high in vitamin C and has several other vitamins and minerals. Selenium is an essential trace element found in this plant. Selenium-enriched broccoli may be a useful dietary ingredient for preventing cancer. Sulforaphane, present in broccoli, mediates growth arrest and apoptosis in human prostate cancer cells [Chiao 2002], and it has been extensively studied in an effort to uncover the mechanisms behind this chemoprotection [Juge, Mithen, and Traka 2007]. Several glucosinolates, a class of phytochemicals, are also reported in broccoli. Broccoli leaf is also edible and contains far more beta-carotenes than the florets. Recently, a report showed that broccoli protects mammalian hearts through the redox cycling of the thioredoxin superfamily [Mukherjee, Gangopadhyay, and Das 2008].

**Tomato (Solanum lycopersicum)**

The tomato (*Solanum lycopersicum*) is herbaceous, a usually sprawling plant, and belongs to the Solanaceae family. Tomatoes are rich in vitamin C and contain lycopene. In the area of food and phytonutrient research, nothing has been hotter in the past several years than studies on lycopene in tomatoes. This carotenoid found in tomatoes has been extensively studied for its antioxidant and cancer-preventing
properties. Carotenoids are naturally occurring organic pigments that are believed to have therapeutic benefit in treating cardiovascular disease because of their antioxidant properties [McNulty et al. 2008]. The antioxidant function of lycopene—its ability to help protect cells and other structures in the body from oxygen damage—has been linked in human research to the protection of DNA (our genetic material) inside of white blood cells. Prevention of heart disease has been shown to be another antioxidant role played by lycopene. Among 72 studies, 57 of them reported inverse associations between tomato intake or blood lycopene level and the risk of cancer at a defined anatomic site; 35 of these inverse associations were statistically significant [Giovannucci 1999], although the FDA found no credible evidence for an association between tomato consumption and a reduced risk of lung, colorectal, breast, cervical, or endometrial cancer [Kavanaugh, Trumbo, and Ellwood 2007]. The FDA found very limited evidence to support an association between tomato consumption and reduced risks of prostate, ovarian, gastric, and pancreatic cancers.

**Bitter Melon (Momordica charantia)**

This annual herbaceous tendril-bearing vine belongs to the family Cucurbitaceae. The plant bears simple leaf, alternate, palmately five-lobed in shape. Fruits are used as vegetables, bitter in taste, green, oblong or ovate, with distinct warty exterior, and the central cavity of the fruit is filled with large flat seeds and pith. Four cucurbitane glycosides, momordicosides Q, R, S, and T, and stereochemistry-established karaviloside XI, were isolated from the bitter melon. These compounds and their aglycones exhibited a number of biologic effects beneficial to diabetes and obesity [Tan et al. 2008].

Acetone extract of whole fruit powder of bitter melon showed regeneration of beta cells in Islets of Langerhans of pancreas of alloxan diabetic rats [Singh and Gupta 2007]. In fact, bitter melon improves insulin sensitivity and insulin signaling in high-fat-fed rats and may open new therapeutic targets for the treatment of obesity/dyslipidemia-induced insulin resistance [Sridhar et al. 2008]. Laboratory tests suggest that compounds in bitter melon might be effective for treating HIV infection [Rebultan 1995; Jiratchariyakul 2001]. In one study, it was shown that MAP30, an anti-HIV plant protein isolated from bitter melon, is capable of acting against multiple stages of the viral life cycle, on acute infection as well as replication in chronically infected cells. Biologically active recombinant MAP30 provides an abundant source of homogeneous material for clinical investigations, as well as structure-function studies of this novel antiviral and antitumor agent [Lee-Huang et al. 1995]. Active biocompounds of bitter melon showed anti-atherogenic property as well [Jayasooriay et al. 2000].

**Bitter Orange (Citrus aurantium)**

Bitter orange is a tree, 7–8 m tall, and spines are axillary and sharp. There is no adequate evidence from efficacy of the nutraceutical drug. Safety concerns have been raised by multiple agencies, but few data are available. Bitter orange is a plant that has been claimed to stimulate weight loss and to be an “ephedra substitute.” It is also
known as Seville orange, sour orange, green orange, neroli oil, and kijitsu. The active ingredients include various alkaloids with selective and agonist activity, including synephrine and octopamine. Synephrine (oxidrine) is a sympathomimetic amine, structurally similar to epinephrine [Dwyer, Allison, and Coates 2005]. The most recent reviews of clinical trials to date found little evidence that *Citrus aurantium* products were effective in weight loss and suggested that more research is needed. Although those reviews reported no adverse events, there has been considerable recent discussion concerning potential harms. FDA approves citrus oils as safe (generally recognized as safe [GRAS]) for natural flavorings in food products. However, the amounts used as supplements may be much higher, and, thus, their GRAS status as flavoring agents may not be relevant to their use in dietary supplements.

Other compounds are sometimes present, such as 6',7',dihydroxybergamottin and bergapten, which may inhibit cytochrome P4503A and increase serum levels of many drugs [Gurley et al. 2004]. However, in one recent clinical study, the *C. aurantium* was devoid of the CYP3A4 inhibitor 6',7',dihydroxybergamottin. More safety testing to assess hemodynamic effects and drug interactions over the short and long term is needed. In summary, larger, longer, and more rigorous trials of *C. aurantium* and synephrine alkaloids are needed to assess their efficacy and safety for weight loss. An additional four clinical trials have examined the effects of *C. aurantium*-containing products in food alone or in combination with other ingredients on body weight and/or body composition [Kalman et al. 2000; Armstrong, Johnson and Duhme 2001; Jones 2001]. In these short-term studies, body weight and/or fat loss appears to be enhanced by *C. aurantium*. This may be partially attributed to a suppressing effect of appetite and/or a moderate increase in resting energy expenditure, but it should be kept in mind that these trials are of short duration, and sample sizes are frequently inadequate.

**NUTRACEUTICAL ANALGESICS**

Analgesics are pain relievers in tablets, creams, lotions, gels, and sprays. It has been widely shown that many plant-derived compounds present significant analgesic as well as anti-inflammatory effects. Doctors often recommend these products in addition to other medications to help temporarily ease pain. There are multiple analgesics available today, among them are capsaicin, a preparation derived from plants, and methylsalicylates, which are derived from willow bark and often combined with menthol. Most of the analgesics and anti-inflammatory food or drugs available today are derived from plants or one can find the origin of analgesic drugs from plants. In this part of the chapter, we will discuss a few important nutraceutical analgesics with their origin, use, and possible adverse effects, if any. The list of nutraceutical analgesics are so big; describing all of them in one book chapter is beyond our scope.

**Aloe (Aloe vera, Aloe indica, Aloe perfoliata)**

The common names of the plants are Chinese aloe, Indian aloe, and True aloe.
It is a succulent herb. The stems are short, suckering freely to form dense clumps. Its leaves are subbasal, slightly distichous in seedlings and new shoots, erect, pale green, and conspicuously exserted.

The leaf juices of the aloe plant have important medicinal uses, making aloe one of the most respected medicinal plants found in many gels, creams, and lotions. The leaf juice or gel is anti-inflammatory, antiseptic, and antifungal.

*Aloe vera* gel consists primarily of water and polysaccharides (pectins, hemicelluloses, glucomannan, acemannan, and mannose derivatives). It also contains amino acids, lipids, sterols (lupeol, campesterol, and β-sitosterol), tannins, and enzymes. Mannose 6-phosphate is a major sugar component. A total of 123 aroma chemicals were identified in the extracts obtained using both gas chromatography and gas chromatography/mass spectrometry. There were 42 alcohols, 23 terpenoids, 21 aldehydes, 9 esters, 8 ketones, 6 acids, 5 phenols, and 9 miscellaneous compounds. The major aroma constituents of this extract by dichloromethane extraction simultaneous purging (DRP) were (Z)-3-hexenol (29.89%), (Z)-3-hexenal (18.86%), (E)-hexenal (7.31%), 4-methyl-3-pentenol (5.66%), and butanol (4.29%). The major aroma constituents of this extract by simultaneous purging and extraction (SPE) were (E)-2-hexenal (45.46%), (Z)-3-hexenal (32.12%), hexanal (9.14%), (Z)-3-hexenol (1.60%), and 3-pentanone (1.41%). Terpenoids were also found as one of the major constituents. The fresh green note of *Aloe* leaves is a result of the presence of these C(6) alcohols and aldehydes as well as terpenoids [Umano et al. 1999]. *Aloe vera* has been traditionally used for burn healing. Cumulative evidence from clinical trials tends to support that aloe might be an effective intervention used in burn wound healing for first- to second-degree burns. However, well-designed trials with sufficient details of the contents of aloe products are lacking to determine the effectiveness of *Aloe vera*.

**Poplar Tree (*Populus balsamifera*)**

*Populus balsamifera* is native to North America. The twig has a bitter aspirin taste. Its bark is greenish gray with lighter lenticels when young, later becoming darker and furrowed with long, scaly ridges. Inner bark is often dried, ground into a powder, and then used as a thickener in soups or added to cereals when making bread.

The leaf buds are antiscorbutic, antiseptic, diuretic, expectorant, stimulant, and tonic [Uphof 1959; Grieve 1984]. The leaf buds are covered with a resinous sap that has a strong turpentine odor and a bitter taste. They are boiled to separate the resin, and the resin is then dissolved in alcohol. The resin is a folk remedy, used as a salve and wash for sores, rheumatism, and wounds [Foster and Duke 1990]. It is made into a tea and used as a wash for sprains, inflammation, and muscle pains. The extract of *Populus* tree inhibited arachidonic acid-induced platelet aggregation [Kagawa et al. 1992]. Pyrocatechol and salicyl alcohol were isolated as active constituents, which showed an inhibitory effect on platelet aggregation induced by arachidonic acid, which was 25 times more potent than aspirin. *Populus* is an important ingredient in an herbal medicine, phytodolor, which is used in painful inflammatory or degenerative rheumatic diseases. The mode of action of phytodolor
includes anti-inflammatory, strong antioxidant, and analgesic properties. Multiple clinical studies and randomized placebo-controlled double-blind trials, performed in different subtypes of rheumatic diseases, confirm the pharmacological evidence of efficacy, such as by reducing the intake of nonsteroidal anti-inflammatory drugs [Gundermann and Muller 2007]. Smoke from the leaves of Populus tree is useful in cutaneous warts. In a clinical trial, smoke from the leaves cures warts completely in 66.7 versus 46.4% compared with conventional cryotherapy [Rahimi, Emad, and Rezaian 2008].

**Salai Guggal (Boswellia serrata)**

*Boswellia serrata* is a medium-sized tree belonging to family Burseraceae, with ash-colored papery bark. *B. serrata* is a close relative of the aromatic frankincense, and both contain the anti-inflammatory boswellian acid and are astringent and anti-inflammatory. It is known as Salai guggal in India. The oleo-gum-resin from the tree *B. serrata*, termed frankincense, is a traditional Ayurvedic remedy. This tree, abundantly growing in dry hilly tracts of India, has been used for a variety of therapeutic purposes [Marinetz, Lohs, and Janzen 1988], such as cancer [Shao et al. 1998], inflammation [Singh and Atal 1986], and arthritis [Sharma, Bani, and Singh 1989], and also including respiratory problems, diarrhea, constipation, flatulence, CNS disorders, rheumatism, liver disease, wound healing, fat reduction, and fevers.

Salai guggal contains essential oil, gum, and resin. Its essential oil is a mixture of monoterpenes, diterpenes, and sesquiterpenes. In addition, phenolic compounds and a diterpene alcohol (serratol) is also found in essential oil. Gum portion of the drug consist of pentose and hexose sugars, with some oxidizing and digestive enzymes. Resin portion is mainly composed of pentacyclic triterpene acid, of which boswellic acid is the active moiety [Kokate, Purohit, and Gokhale 1999]. A new lupane triterpene was isolated from fractionation of methanol extract of *B. serrata* resin together with Boswellic acids [Pardhy and Battacharya 1978]. The fraction on additional purification with ethanol/hexane (1:1) yielded 3a-hydroxy-lup 20(29) ene-24-oic acid, whose structure was confirmed by nuclear magnetic resonance and mass spectrometry [Culioli et al. 2003].

There are many new studies and emerging data to suggest that *Boswellia* may have a role to play in the management of IBD [Joos et al. 2006; Clarke and Mullin 2008]. In a study involving a rat model of colitis, investigators showed that oral administration of *Boswellia* extract or acetyl-11-keto-β-BA over a two-day period resulted in a dose-dependent decrease in rolling (up to 90%) and adherent (up to 98%) leukocytes. In addition, necropsy showed improvement of inflammatory changes on both a macroscopic and microscopic level [Kriegstein et al. 2001]. Clinical trials using oleo-gum-resin of *B. serrata* in India and Germany reported improvement in at least one end point of IBD patients. The mechanism of action of Boswellic acid and oleo-gum-resin is not clearly understood, but it is indicated that it is attributable to inhibition of 5-lipoxygenase. However, other factors, such as cytokines (interleukins [ILs] and tumor necrosis factor α [TNF-α]) and the complement system, are also candidates for its action.
Camphor (Cinnamomum camphora)

The camphor tree is a dense broad-leaf evergreen that is capable of growing 50–150 feet (15.2–45.7 m) tall and spreading twice that wide, with a trunk up to 15 feet. The shiny foliage is made up of alternate 1–4 inch (2.5–10.2 cm) oval leaves dangling from long petioles. Each leaf has three distinct yellowish veins. The inconspicuous tiny cream-colored flowers are borne in the spring on branching 3 inch (7.6 cm) flower stalks. They are followed by large crops of fruit, comprising round pea-sized berries attached to the branchlets by cup-like little green cones. The berries first turn reddish and then ripen to black. Camphor tree can be readily identified by the distinctive odor of a crushed leaf. Camphor is present in every part of the tree but is usually taken from the wood of mature trees by steam distillation. Oil is clear and has a scent similar to eucalyptus. It has a duality of hot and cold actions, cooling at first touch and then stimulating heat and circulation. It is very useful in rheumatic inflammation. Ophthacare clinical trials show that C. camphora with other herbal ingredients improves the patients suffering from various ophthalmic disorders, namely conjunctivitis, conjunctival xerosis (dry eye), and acute dacryocystitis [Biswas et al. 2001].

Chamomilla (Chamomile matricaria recutita; synonym Matricaria chamomilla)

Chamomilla belongs to the Compositae family. It is a perennial herb found in dry fields and around gardens and cultivated grounds. The white ray florets are furnished with a ligule, whereas the disc florets are yellow. The hollow receptacle is swollen and lacks scales.

The flowers of chamomile provide 1–2% volatile oils containing α-bisabolol, α-bisabolol oxides A and B, and matricin (usually converted to chamazulene). Other active constituents include the bioflavonoids apigenin, luteolin, and quercetin [McKay and Blumberg 2006]. These active ingredients contribute to chamomile’s anti-inflammatory, antispasmodic, and smooth muscle-relaxing effects, particularly in the gastrointestinal tract [Rodriguez-Fragoso et al. 2008].

Hemp/Cannabis, Marijuana (Cannabis sativa)

This plant belongs to the family Urticaceae. Cannabis sativa has been cultivated for over 4,500 years for different purposes, as fiber, oil, or narcotics. It is an annual herb, usually erect, and the stems are variable, up to 5 m tall, with resinous pubescence, are angular, and are sometimes hollow. Medicinally, plant is a tonic, intoxicant, stomachic, antispasmodic, analgesic, narcotic, sedative, and anodyne.

Most varieties contain cannabinol and cannabinin. Egyptian variety contains cannabidone, cannabiol, and cannabinol, their biological activity being attributable to the alcohols and phenolic compounds. Per 100 g, the seed is reported to contain 8.8 g of H₂O, 21.5 g of protein, 30.4 g of fat, 34.7 g of total carbohydrate, 18.8 g of fiber, and 4.6 g of ash. In Asia, per 100 g, the seed is reported to contain 421 calories,
13.6 g of water, 27.1 g of protein, 25.6 g of total carbohydrate, 20.3 g of fiber, 6.1 g of ash, 120 mg of Ca, 970 mg of phosphorus, 12.0 mg of iron, 5 mg of beta-carotene equivalent, 0.32 mg of thiamine, 0.17 mg of riboflavin, and 2.1 mg of niacin. A crystalline globulin has been isolated from defatted meal. It contains 3.8% glycocol, 3.6% alanine, 20.9% valine and leucine, 2.4% phenylalanine, 2.1% tyrosine, 0.3% serine, 0.2% cystine, 4.1% proline, 2.0% oxypoline, 4.5% aspartic acid, 18.7% glutamic acid, 14.4% tryptophane and arginine, 1.7% lysine, and 2.4% histidine. Oil from the seeds contains 15% oleic, 70% linoleic, and 15% linolenic and isolinolenic acids. The seed cake contains 10.8% water, 10.2% fat, 30.8% protein, 40.6% N-free extract, and 7.7% ash (20.3% K2O, 0.8% Na2O, 23.6% CaO, 5.7% MgO, 1.0% Fe2O3, 36.5% P2O5, 0.2% SO3, 11.9% SiO2, 0.1% Cl, and a trace of Mn2O3). Trigonelline occurs in the seed. Cannabis also contains choline, eugenol, guaiacol, nicotine, and piperidine (Council for Scientific and Industrial Research, 1948–1976), all listed as toxins by the National Institute of Occupational Safety and Health. Cannabinoids (CBs) are chemical compounds derived from cannabis. Animal models demonstrate that CB receptors on immune cells play a fundamental role in peripheral, spinal, and supra-spinal nociception, and CBs are effective analgesics [Hosking 2008]. Clinical trials of CBs in multiple sclerosis have suggested a benefit in neuropathic pain. CBs are also used as a powerful pain management drug for cancer patients. Experience from multiple case studies and clinical trials in Phases I–III demonstrate marked improvement in subjective sleep parameters in patients with a wide variety of pain conditions, including multiple sclerosis, peripheral neuropathic pain, intractable cancer pain, and rheumatoid arthritis, with minimum adverse events. In another study, CBs are no more effective than codeine in controlling pain and have depressant effects on the CNS. Use of CBs into clinical practice for pain management is therefore undesirable. Cannabis is traditionally used in the treatment of multiple sclerosis. Anecdotal evidence suggests that it may be beneficial in controlling symptoms such as spasticity, pain, tremor, and bladder dysfunction in multiple sclerosis patients. Recent research in animal models of multiple sclerosis has showed that CBs are able to control disease-induced symptoms such as spasticity and tremor and help patients suffering from the severity of the disease. CBs from C. sativa present an interesting therapeutic potential as antiemetics, appetite stimulant, analgesics, and in the treatment of spinal cord injuries, Tourette’s syndrome, epilepsy, and glaucoma.

**OTHER NUTRACEUTICALS FROM PLANTS:**
**PLANTS WITH NO BOUNDARIES**

**Tulsi (Ocimum sanctum)**

Tulsi has been used in India for thousands of years and has been described as queen of all herbs. This most sacred aromatic plant of India belongs to the family Lamiaceae. It is an erect, many-branched subshrub, with simple opposite green or purple ovate leaves that are strongly scented with hairy stems. Flowers are purplish in elongate racemes in close whorls [Warrier 1995].

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In traditional Indian medicine, this plant is used to treat several diseases such as bronchitis, bronchial asthma, malaria, diarrhea, dysentery, skin diseases, arthritis, painful eye diseases, chronic fever, and insect bites. This plant has also been suggested to possess antifertility, anticancer, antidiabetic, antifungal, antimicrobial, hepatoprotective, cardioprotective, antiemetic, antispasmodic, analgesic, adaptogenic, and diaphoretic actions [Prakash and Gupta 2005]. Different chemical compounds, such as eugenol, luteolin, ursolic acid, and oleanolic acid, was isolated from the leaf of green and black varieties of tulsi [Anandjiwala, Kalola, and Rajani 2006]. Kaul et al. [2005] showed that high-performance liquid chromatography purified polyphenolic fraction IV of tulsi may have a profound antiatherogenic effect. The two water-soluble flavonoids orientin and vicenin isolated from the leaves of the Indian plant Ocimum sanctum was found to provide radioprotective effect in mice [Uma et al. 1999]. Studies have also shown tulsi to be effective for diabetes [Kapoor 2008], and the beneficial effect on blood glucose levels is attributable to the antioxidant properties of this plant [Sethi et al. 2004].

**Danshen (Salvia miltiorrhiza)**

Danshen is a perennial herb that grows on sunny hillsides and stream edges mainly in China. Its violet-blue flowers bloom in the summer, and the leaves are oval, with finely serrated edges. It belongs to the family Lamiaceae. Remedies containing danshen are used traditionally to treat a diversity of ailments, particularly cardiac (heart) and vascular (blood vessel) disorders such as atherosclerosis or blood clotting abnormalities. The ability of danshen to “thin” the blood and reduce blood clotting is well documented, although the herb’s purported ability to “invigorate” the blood or improve circulation has not been demonstrated in high-quality human trials. According to multiple randomized clinical trials of danshen on patients of acute myocardial infarction (AMI), the evidence to support use of danshen preparations is too weak to make any judgment about its effects. Evidence from randomized clinical trials is insufficient and of low quality [Wu, Ni, and Wu 2008].

Danshen is used in traditional Chinese medicine (TCM) to promote blood flow and treat cardiovascular diseases. It is sold in over-the-counter herbal preparations, prescribed by TCM doctors, and administered in Chinese hospitals for angina pectoris [Lei and Chiou 1986a], AMI [Liu et al. 1992], and ischemic and thrombotic disorders. *In vitro* and animal studies suggest that it may be vasoactive, scavenge free radicals [Ji, Tan, and Zhu 2000], and inhibit platelet aggregation [Han et al. 2008]. This Chinese herbal treatment for AMI is widely used in China in addition to usual western forms of therapy in the treatment of AMI. However, there is no strong evidence to support its use, and few rigorous studies have been conducted. Well-designed and randomized trials are needed to provide adequate evidence of its role in the treatment of AMI. The active compounds in danshen are tanshinones and phenolic compounds [Hu et al. 2005; Cao et al. 2008]. Danshen has been studied in China for AMI and ischemic heart disease [Hu et al. 2005]. Most studies are neither placebo controlled nor blinded and often use danshen combined with other herbs. No differences in cardiac contractility, compliance, inotropy, blood viscosity, or
fibrinogen were found. Danshen has been studied for artery vasodilation, the mechanism underlying its use in angina [Zhou et al. 2005]. At low dose, it causes generalized vasodilation and decreases blood pressure [Lei and Chiou 1986b]. At higher doses, however, it causes vasoconstriction in noncoronary arteries [Lei and Chiou 1986; Zhou et al. 2005]. Animal studies confirm that danshen decreases warfarin clearance and increases bioavailability [Chan et al. 1995].

Horse Chestnut Seed (*Aesculus hippocastanum*)

*Aesculus hippocastanum* is a large deciduous tree, commonly known as horse chestnut or conker tree, and belongs to the family Sapindaceae. Seeds of horse chestnut contain saponins, known collectively as “aescin,” which have a gentle soapy feel and are potent anti-inflammatory compounds. Saponins, such as aescin, also reduce capillary fragility and therefore help to prevent leakage of fluids into surrounding tissues, which can cause swelling. An extract of horse chestnut has been shown recently to have one of the highest “active-oxygen” scavenging abilities of 65 different plant extracts tested. Such extracts are more powerful antioxidants than vitamin E and also exhibit potent cell-protective effects that are linked to the well-known antiaging properties of antioxidants [Wilkinson and Brown 1999]. The active compound aescin is a mixture of triterpene glycosides [Kapusta et al. 2007]. Aescin decreases lower-extremity edema by decreasing capillary permeability via inhibition of endothelial lysosomal enzymes and preservation of capillary wall glycocalyx [Wilkinson and Brown 1999] and vasoconstriction via prostaglandin F2 [Fujimura et al. 2007]. Extracts standardized for aescin content are available, and the Commission E recommends 50 mg of aescin twice daily [Loew et al. 2000]. A review of eight placebo-controlled trials for venous insufficiency reported that lower-extremity circumference and volume decreased, and leg pain and pruritus improved [Pittler and Ernst 1998, 2004, 2006]. The most frequent adverse effects were gastrointestinal symptoms, dizziness, headache, and pruritus. Trials that compared horse chestnut with hydroxyethylrutosides, a semisynthetic mixture of flavonoid compounds [Pittler and Ernst 2004], found little difference between treatments. In a partially blind study of horse chestnut seed versus compression stockings or placebo, the volume of lower-extremity edema decreased 45 ml for each active treatment compared with a 10 ml increase for placebo. Side effects include pruritus, nausea, headache, and dizziness [Pittler and Ernst 1998]. There is one reported case of hepatitis from a commercial preparation of horse chestnut extract, Venoplant [Takegoshi et al. 1986]. Venocuran, an herbal preparation that contained horse chestnut, plus phenopyrazone, extracts of white squill, convallaria, oleander, and adonis, was removed from the market because of a systemic lupus-like syndrome.

Feverfew (*Tanacetum parthenium*; synonym, *Chrysanthemum parthenium*)

Feverfew is a small herb that grows from a few inches to 2 feet and belongs to the family Asteraceae. It is leaf lobed, the margins are entire or dentate, and the flowers
capitulate. It is a contracted raceme composed of numerous individual sessile flowers, called the florets, and shares the same receptacle. Fruits are specialized achene, sometimes called cypsela, with one seed per fruit.

Feverfew is primarily used for migraine prophylaxis [Evans and Taylor 2006]. It inhibits platelet release of serotonin [Silberstein 2001] and may have vasoactive effects [Silberstein 2001]. The active compound in feverfew, parthenolide, is a sesquiterpene lactone. Other compounds have been investigated for biologic activity, most notably flavonoids for a potential anti-inflammatory effect [O’Hara et al. 1998]. Feverfew is one of a few herbs for which data on the content of the active compounds in commercial preparations are available [Wu et al. 2007]. Typical daily doses for migraine prophylaxis are 50–100 mg of whole or powdered dried leaves, corresponding to 500 g of parthenolide [Maizels, Blumenfeld, and Burchette 2006; Wu et al. 2007]. In vitro studies demonstrate that feverfew and parthenolide inhibit platelet aggregation and platelet and leukocyte release of serotonin [Till et al. 1989]. In vitro vasoactive effects vary with the formulation. Chloroform extracts of fresh leaves inhibit smooth muscle contractility, but extracts of dried leaves elicit a contractile response. Because chloroform extracts of dried feverfew do not contain measurable amounts of parthenolide, other vasoactive compounds may be present [Heptinstall et al. 1985]. Feverfew’s inhibition of platelet serotonin release in vitro raises concerns about interaction with anti-serotonin migraine prophylactic drugs [Haaz et al. 2006] and potentiation of bleeding with antiplatelet agents. However, serious adverse events or interactions have not been reported.

**Ephedra (Ephedra sinica)**

Ephedra is an evergreen shrub that grows up to 0.5 m, and it belongs to the family Ephedraceae. Ma huang is a natural source of ephedrine and has potent sympathomimetic activity. Herbal remedies and soft drinks used for energy or weight loss often contain ma huang. In past few years, this plant has been extensively studied for its medicinal uses, there are 35 clinical trials, and 47 observational studies had been done on Ephedra showing its effect on weight loss [Lenz and Hamilton 2004; Pittler and Ernst 2004; Haaz et al. 2006; Norris et al. 2005]. Ephedra contains the chemicals ephedrine and pseudoephedrine, which are bronchodilators used for nasal allergies and asthma [Bielory 2004]. It has been used and studied to treat asthma and chronic obstructive pulmonary disease in both children and adults [Lanski et al. 2003; Avois 2006]. Other treatments, such as beta-agonist inhalers, are more commonly recommended as a result of safety concerns with ephedra or ephedrine. One hundred five different studies on human and animals show its adverse effects and toxicity. Between 1997 and 1999, a total of 140 reports of adverse events were related to ma huang; 13 caused permanent impairment, and 10 resulted in death. Many reports concern healthy young people without known cardiac disease. The majority had new-onset hypertension [Ernst 2003; Richard and Jurgens 2005], and other findings included cerebrovascular accidents, arrhythmias and myocardial infarction [Rogers, Shin, and Wang 1997; Bohn, Khodaee, and Schwenk 2003]. Several reports link the adverse
response of ma huang to concurrent use of caffeine or exercise [Avois et al. 2006; Chitturi and Farrell 2008].

**Dong Quai (Angelica sinensis)**

*Angelica sinensis* (commonly known as dong quai) is a fragrant, perennial herb found in mainland China, Japan, and Korea. It belongs to family the Umbelliferae and grows to $1 \times 0.7$ m. The dried root is valued for its therapeutic properties. Its flavor is a distinct blend of bitter, sweet, and pungent, and its overall effect is warming in nature.

Dong quai has been called the “female ginseng” and is excellent as an all-purpose women’s herb. Dong quai is also considered a TCM remedy for menstrual symptoms and menopause [Haines et al. 2008]. Clinical studies found no significant difference between dong quai and placebo in the treatment of vasomotor symptoms in Hong Kong Chinese women. The frequency of mild, moderate, and severe hot flushes decreased in both treatment and placebo groups, but dang quai was statistically superior to placebo only in the treatment of mild hot flushes. There were no serious adverse effects found during the course of the study [Haines et al. 2008].

Dong quai root contains 0.4–0.7% volatile oil, the key components of which are $n$-butylidenephthalide, ligustilide, $n$-butylphthalide, ferulic acid, nicotinic acid, and succinic acid [Duke 1992]. Significant amounts of vitamin A and carotenoids (0.675%), vitamin B$_{12}$ (0.25–0.40 mcg/100 g), vitamin E, ascorbic acid, folic acid, biotin, various phytosterols (e.g., $\beta$-sitosterol), calcium, magnesium, and other essential macrominerals are also found in dong quai root. This plant is also used for antithrombotic, antiasthmatic, and analgesic effects [Chang et al. 2005; Dong et al. 2006; Gao et al. 2006]. In humans, dong quai has been evaluated for estrogenic effects [Gao et al. 2007]. Antithrombotic effects are attributed to coumarin derivatives and ferulic acid contained in the oil of the root [Chang et al. 2005]. Ferulic acid may cause platelet dysfunction by inhibiting production of thromboxane A2. In a controlled trial of 96 subjects with new cerebral thrombosis or embolism, there was no difference in improvement rate with dong quai [Liao et al. 1989]. The root, dang quai, is valuable in anemia and menstrual pain or as a general tonic after childbirth [Shen et al. 2005]. It clears liver stagnation (of both energy and toxins) and can relieve constipation, especially in the elderly.

**Kava (Piper methysticum)**

Kava is a shrub about 6 feet high, somewhat resembling the bamboo in growth, and belongs to the family Piperaceae. The root is the part recommended for use in medicine. The main root seems to grow horizontally beneath the surface of the ground, sending up stalks at intervals of from 2 to 4 inches. Each stalk is from 0.5 to 3 inches in diameter at the base and is hollow. Externally, the main root is brown and covered with a thin bark. From the sides and lower part are secondary roots, about 0.5–0.75 inches in diameter. These appear to be arranged about the bases of the stalks; in some cases, they are quite long and send out rootlets at a distance of

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6 inches from the main root. Aboriginal peoples of the South Pacific, as an anxiolytic, use kava, a member of the black pepper family, and it has been promoted to treat anxiety, depression and muscle tension [Saeed, Bloch, and Antonacci 2007; van der Watt, Laugharne, and Janca 2008]. Kava pyrones, the active compounds in kava [Schulze, Raasch, and Siegers 2003], may inhibit cyclooxygenase and thromboxane synthase. A small observational study of an aboriginal community found that high-density lipoproteins (HDLs) were higher in kava users [Clough, Rowley, and O’Dea 2004]. Adverse effects include rash, elevated hepatic enzymes, pulmonary hypertension, and hepatitis [Schulze, Raasch, and Siegers 2003; Stickel and Schuppan 2007]. Kava may also interact with benzodiazepines, inducing coma [Izzo and Ernst 2001; Hu et al. 2005].

**Licorice (Glycyrrhiza glabra)**

Licorice, an extract of the root of *Glycyrrhiza glabra*, is used as a sweetening and flavoring agent. This plant is used as an herbal remedy for gastritis and upper respiratory tract infections [Fiore et al. 2008]. The active constituent of licorice is glycyrrhizic acid [Baltina 2003]. A metabolite, glycyrrhetinic acid, inhibits renal 11-hydroxysteroid dehydrogenase and causes a state of mineralocorticoid excess by impeding the inactivation of cortisol [Baltina 2003]. Case reports link licorice to hypertension, hypertensive encephalopathy, pulmonary edema, hypokalemia, arrhythmias, congestive heart failure, muscle weakness, and acute renal failure [Schambelan 1994; Thayagarajan et al. 2002; Coon and Ernst 2004]. Dilated cardiomyopathy resulting from excessive use of licorice and glycyrrhizin for gastritis has been reported [Schambelan 1994]. Fifty to 100 g of confectionary licorice, or 50–300 mg of glycyrrhetinic acid, over weeks may cause adverse effects [Cosmetic Ingredient Review Expert Panel 2007]. A study of 30 healthy, normal volunteers reported that 100 g/day of licorice (270 mg of glycyrrhizic acid) over four weeks increased systolic blood pressure 6.5 mm Hg and decreased plasma potassium 0.24 mmol/L from baseline [Schambelan 1994; Ferrari et al. 2001]. Susceptibility to licorice varies greatly; subjects with underlying hypertension and women may be more sensitive [Mattarello et al. 2006; Sigrunsdottir et al. 2006]. Dietary consumption of licorice acts as an antioxidant and is reported to help in reducing cardiovascular inflammation and athrosclerosis; licorice-root extract by hypercholesterolemic patients may act as a moderate hypocholesterolemic nutrient and a potent antioxidant agent and hence fight cardiovascular disease [Fuhrman et al. 2002].

**Ginseng (Panax ginseng)**

Ginseng refers to the root of *Panax* species and belongs to the family Araliaceae. The most commonly examined species are *Panax ginseng* (Asian ginseng), *Panax quinquefolius* (American ginseng), and *Panax japonicus* (Japanese ginseng). The terms “red” and “white” refer to different methods of ginseng preparation, not different species. Ginseng is believed to promote vigor, potency, well-being, and longevity. In China, it is used for angina pectoris, myocardial infarction, and congestive heart...
failure. It has been evaluated for many other indications, most notably for use as an antihyperglycemic. It is administered as a whole dried root, extract, tea, or capsule. The active compounds are heterogeneous triterpene saponin glycosides, collectively termed ginsenosides. The exact ginsenosides vary by Panax species, root age, and preparation method [Valli and Giardina 2002]. The actions of specific ginsenosides vary and, in some instances, are inconsistent.

In multiple double-blind clinical trials on the effect of ginseng on erectile dysfunction and on female sexual function and libido [Choi, Seong, and Rha 1995; Ito et al. 2006], ginseng shows marginal improvements in patients’ conditions. In a total of 90 patients with 30 patients in each group, changes in symptoms such as frequency of intercourse, premature ejaculation, and morning erections after treatment were not changed in all three groups.

However, in the group who received ginseng, changes in erectile parameters such as penile rigidity and girth, libido, and patient satisfactions were significantly higher than that of other groups. The overall therapeutic efficacies on erectile dysfunction were 60% for the ginseng group and 30% for the placebo- and trazodone-treated groups, statistically confirming the effect of ginseng. Ginseng is useful in viral myocarditis, which is a heart disease when the muscles in the walls of heart become infected with a virus. Ginseng preparation showed significant effects on reducing myocardial enzymes and improving cardiac function with no serious adverse effect reported in a clinical trial on viral myocarditis [Liu, Yang, and Du 2004]. Ginseng has been studied in some depth as an antifatigue agent; preclinical evidence shows some immune-stimulating activity [Block and Mead 2003].

CONCLUSION

It is clear from clinical trials and studies that nutraceuticals are more preventive than curative. If people use them wisely and in their food regularly, medicinal compounds present in the food will keep them healthy and disease free. How to make use of these food and spices full of medicinal values in our daily life is always a challenge for people and dieticians. In some ancient cultures and traditions, as in Indian and Chinese traditions, these food materials with medicinal values are integrated into the lifestyle in many ways. For example, spices such as turmeric, chili, and all the mentioned spices in this chapter are used as regular seasoning in curries and soups. Regular daily diets in many cultures contain fruits and milk in everyday use. Extensive epidemiological studies and investigations are required to confirm the occurrence of the major diseases and dietary habits in different parts of the world.

Not only are these plants and plant products used in regular diets, but these plants are also tacitly connected to the people by involving them in people’s faith (i.e., inculcating plants and trees in religious practices). Involving plants and plant products in religious faiths not only shows the importance of plants in human lives but also protects and conserves the ecosystem by respecting and preserving them.

Ancient art and science of traditional medicine or Ayurveda (ayus, meaning “life” and veda, meaning “science”) was developed about 5,000 years ago in ancient
India. The *Sushruta Samhita* and the *Charaka Samhita* were influential works on traditional medicine of India during that period. Both are now identified worldwide as important early sources of medical understanding and practice, independent of ancient Greek civilization. Ayurvedic medicine provided clues that lead to the discovery of thousands of phytochemicals from medicinal plants. The active compounds have physiological benefits or provide protection against a chronic disease. Food also plays a major role in the concepts of illness and curing. Therapeutic actions are maximally effective only if appropriate dietary measures are taken to support the restoration of physiological balance. Furthermore, food and spices themselves constitute an integral part of traditional medical prescriptions. These traditional prescriptions contain small amounts of micronutrients and active biocompounds that are consumed daily in much higher quantities.

“Plants are a source of many biologically active products and nowadays they are of great interest to the pharmaceutical industry. The study of how people of different culture use plants in particular ways has led to the discovery of important new medicines” [Borges et al. 2005]. Therefore, ancient literature on plant use, medicinal plants used by different tribes around the world, could provide a more vital clue to the discovery of many more phytochemicals from the nutraceutical herbs. Massive monetary investment and intense research is required. Because of irresponsible human acts of mass destruction of forests worldwide, we are losing flora at an alarming rate. Unless we act immediately to preserve the medicinal plants, plants with nutraceutical values, future generations will loose tremendous health and wellness benefits from nutraceutical herbs that we are enjoying now. We can expect that, in the near future, most active biocompounds will be taken along with vitamin pills everyday to prevent and cure disease.

**FOR MORE INFORMATION AND RESEARCH**


REFERENCES


Anandjiwala, S., J. Kalola, and M. Rajani. 2006. Quantification of eugenol, luteolin, ursolic acid, and oleolic acid in black (Krishna Tulasi) and green (Sri Tulasi) varieties of *Ocimum sanctum* Linn. using high-performance thin-layer chromatography. *J. AOAC Int.* 89:1467–1474.


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