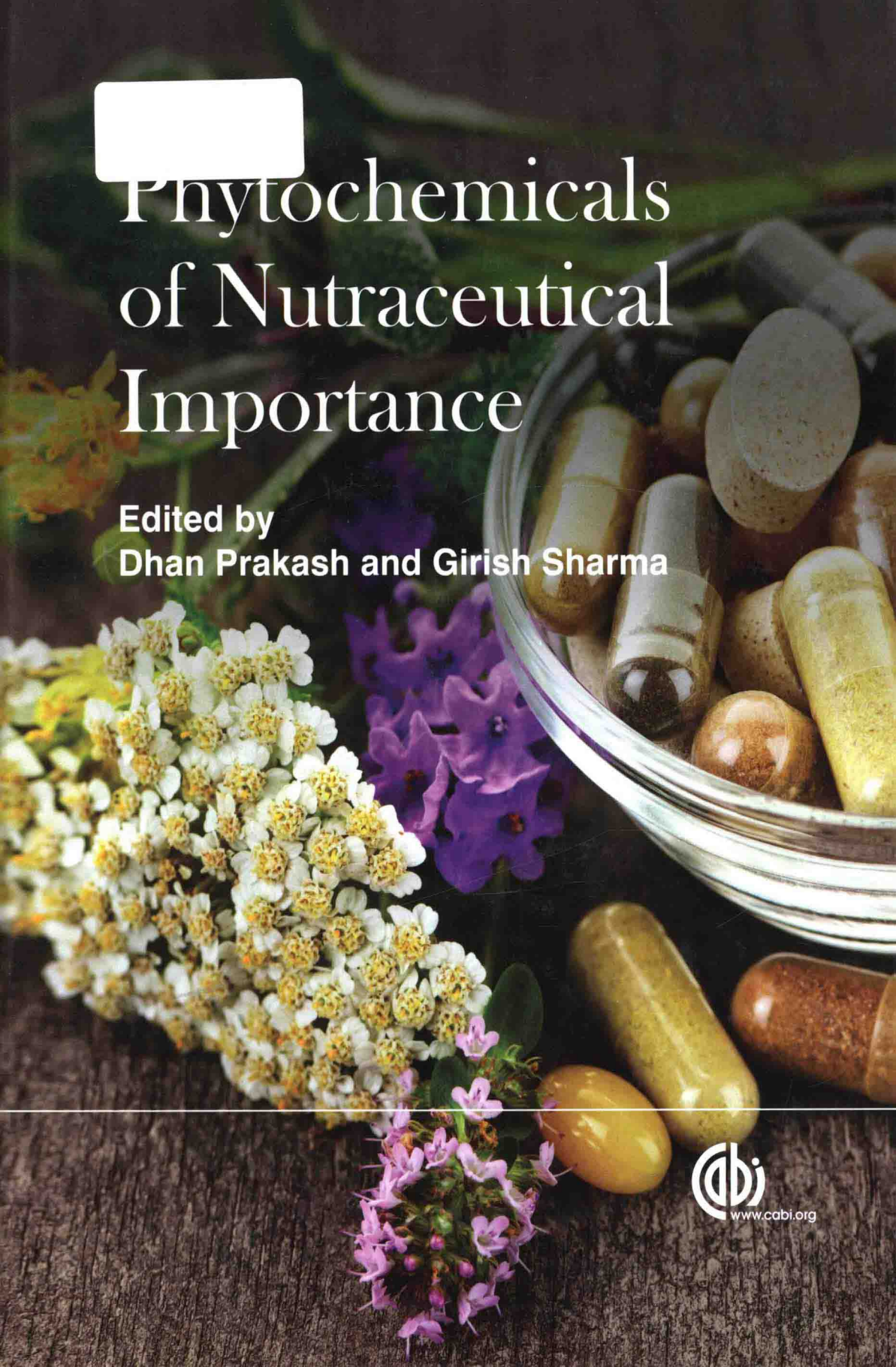
Phytochemicals of Nutraceutical Importance

Edited by
Dhan Prakash and Girish Sharma



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Preface

The word nutraceuticals is derived from the nutrition and pharmaceuticals that provide health and medical benefits, including the prevention and treatment of disease. A potential nutraceutical is one that holds a promise of a particular health or medical benefit; such a potential nutraceutical only becomes established after there are sufficient clinical data to demonstrate such a benefit. Therefore, a nutraceutical is exhibited to have a physiological benefit or provide protection against chronic disease. Such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered foods, herbal products and processed foods. Their bioactive ingredients, the phytochemicals, sustain or promote health and occur at the crossroads of the food and pharmaceutical industries. They play a crucial role in maintaining optimal immune response, such that deficient or excessive intakes can have negative impacts on health. The growing awareness of nutraceutical benefits and shift of healthcare economics in favour of nutraceuticals brought nutraceuticals into the spotlight of government health policies in various countries. Epidemiological and animal studies suggest that the regular consumption of fruits, vegetables and whole grains reduces the risk of chronic diseases.

The present book describes evidences for protective and health-beneficial effects of phytochemicals of nutraceutical importance and is divided into six parts. Part I provides an introduction and overview of phytochemicals of nutraceutical importance. These are non-nutritive plant chemicals, bioactive constituents that sustain or promote health. They may range from isolated nutrients, dietary supplements and specific diets to genetically engineered designer foods, herbal products, processed foods and beverages. The phytochemicals, either alone or in combination, have significant therapeutic potential in curing various ailments. They play positive pharmacological effects in human health as antioxidants, antibacterial, antifungal, anti-inflammatory, anti-allergic, antispasmodic, anti-aging, antidiabetes, chemopreventive, hepatoprotective, neuroprotective, hypolipidaemic, hypotensive, diuretic, CNS stimulant, immuno-modulator, carminative, analgesic, induce apoptosis and protect from osteoporosis, DNA damage, cancer and heart diseases.

In Part II, Phytochemicals in Disease and Prevention Therapy, Chapter 2 deals with progressive chronic kidney disease (CKD), which is debilitating, generally irreversible, and is associated with considerable morbidity and mortality, especially when it progresses to end stage kidney disease (ESKD) where patients require dialysis or transplant to survive. Although conventional therapies, such as angiotensin converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARB), do have some beneficial outcomes in blocking progression of

fibrosis, they are by no means perfect therapies because, even with these drugs, CKD progression is often insidious and persistent. Phytochemicals, and other complementary therapies, may provide a beneficial adjunct to these conventional drugs. Chapter 3 deals with natural products in the prevention of cancer, investigating clues in traditional diets for potential modern-day cures. As the process of acculturation occurs globally, traditional diets are being replaced with foods typically associated with Western cultures. Traditional diets have disease-fighting compounds that need to be introduced into diets in order to restore their disease preventing abilities. Chapter 4 describes resveratrol as a chemo-preventative agent with diverse applications. It is an antioxidant synthesized by wine grapes as a natural defence against both fungal infections and UV light. Preclinical and clinical trials have established the therapeutic effects of resveratrol, including the treatment of various cancers, lipid disorders, anti-inflammatory, neuroprotective, cardioprotective and anti-ageing activity.

In Part III, Potential Alternative Therapeutic Dietary Supplements, Chapter 5 deals with synbiotics promoting gastrointestinal (GI) health. The metabolic processes of various bacteria and the interactions with dietary inputs impact GI tract health and have systemic influences. The concept of nutritionally using a prebiotic and probiotic in a synbiotic relationship to increase the relative number of beneficial bacteria in the gut is a new and promising area of investigation. Synbiotics may be useful in treating some skin ailments, chronic kidney disease, diarrhoea and inflammatory bowel disease. Chapter 6 describes that nature is an attractive source of new therapeutic compounds with tremendous chemical diversity. Exploitation of microorganisms are being employed for the large scale production of a variety of biochemicals ranging from alcohol to antibiotics and processing of foods and feeds. Microorganisms have a great potential as nutraceuticals and can be used to combat diseases such as protein energy malnutrition, anaemia, diarrhoea, cancer, obesity, ulcerative colitis, Crohn's disease, irritable bowel syndrome and gluten therapy resistant celiac. Chapter 7 describes phytochemicals of nutraceutical importance from cactus and their role in human health. Cacti have been used by ancient civilizations to cure diseases and heal wounds. Cactus cladodes, fruits and flowers have been traditionally used as natural medicines in several countries. Cactus products may be efficiently used as a source of several phytochemicals of nutraceutical importance.

In Part IV, Importance and Benefits of Dietary Phytopharmaceuticals, Chapter 8 deals with the role of omega 3 and omega 6 fatty acids in human health. Foods must supply two essential fatty acids such as linoleic acid and α-linolenic acid, which accomplish fundamental and highly specific physiological roles in humans and are involved in protection from cardiovascular disease, nervous tissue, retina function, seminal glands, inflammatory process, immunity, etc. Chapter 9 deals with glucosinolates present in cruciferous vegetables, which are considered as one of the most significant biologically active phytochemicals with anticancer properties. Consumption of plants of *Brassica* species provides protection against carcinogenesis, mutagenesis and other forms of toxicity of electrophiles and reactive oxygen species. Chapter 10 describes phytoestrogens, which can structurally or functionally mimic mammalian oestrogens and show potential benefits for human health, serving as potential alternatives to the synthetic selective oestrogen receptor modulators currently being used in hormone replacement therapy. Chapter 11 describes phytosterols and their healthy effects. They compete with cholesterol in the intestine for uptake, and aid in the elimination of cholesterol from the body. They are found to exhibit anti-inflammatory, antineoplastic, antipyretic and immunomodulating activity. Chapter 12 deals with the chemistry and health benefits of carotenoids, which comprise carotenes and oxycarotenoids as two main groups of fat-soluble pigments, widely distributed in nature. Carotenes along with xanthophylls, astaxanthin, lycopene and lutein seem to offer protection against lung, colorectal, breast, uterine and prostate cancers. They help to prevent heart disease, and supplementation along with vitamin C and E reduces the risk of developing diabetes and to fight against Alzheimer's disease.

In Part V, Antioxidant Phytonutrients and their Therapeutic Values, Chapter 13 describes phenolic acids as natural antioxidants for reducing lipid oxidation, extending the shelf life of

edible fats and oils, replacing synthetic phenolic antioxidants. They are quite common in plants and contribute to the taste and flavour characteristics of many spices. Their antioxidant activity is related to their mechanism of trapping free radicals and their potency is related to their chemical structure. Chapter 14 explains the role of antioxidant polyphenols in nutraceuticals and human health. Polyphenols are considered to be the most effective antioxidants; they can also intensify the activity of other antioxidants. Antioxidants may be of significant importance to offer protection against various degenerative diseases such as cancer, diabetes mellitus, inflammatory diseases, neurodegenerative disorders and ageing. Natural polyphenols afford protection against various stress-induced toxicities through modulating intercellular cascades which inhibit inflammatory molecule synthesis, the formation of free radicals, nuclear damage and induce antioxidant enzyme expression. Chapter 15 deals with the use of antioxidant phytochemicals in cancer chemoprevention. *In vitro* and *in vivo* studies show their potency as preventive and therapeutic agents for various stages and types of cancer. There are several obstacles for the effective use of these phytochemicals for their medicinal values. The proven phytochemicals such as epigallocatechin-gallate (EGCG), curcumin, silibinin, resveratrol and genistein show less bioavailability and durability *in vivo*. Chapter 16 describes antioxidants, their roles and plant sources. Excessive amounts of free radicals are thought to be related to the development of conditions such as heart and liver disease, cancers, arthritis and accelerated ageing. Plants produce an impressive array of antioxidant compounds, which includes carotenoids, flavonoids, tocopherols, tocotrienols, cinnamic acids, benzoic acids, folic acid and ascorbic acid etc. Antioxidants present in the diet enter the blood and are delivered to the cells directly to protect them from damage by free radicals.

In Part VI, Potential Traditional and Novel Food Interventions, Chapter 17 deals with phytochemicals of nutraceutical importance from *Curcuma longa* and their role in human health. *Curcuma longa* is used as a spice, colouring matter and preservative and has a wide range of medicinal and pharmacological activities. It exhibits anti-inflammatory, antioxidant, antibacterial, antiparasitic, nematocidal, anti-human immunodeficiency virus, antispasmodic, antimalarial and anticarcinogenic activities. Chapter 18 considers the phytochemistry of plants used in traditional medicine. There is an increasing interest in natural plant products as a source of biologically active phytopharmaceuticals and an urgent need to develop new clinical drugs. This is a timely review of the latest advances and trends in a field that is becoming commercially significant in the pharmaceutical industry. Chapter 19 deals with vitamins, minerals, their roles and plant sources. These are essential for proper functioning of the human body and provide medicinal benefits. They work individually as well as synergistically. Vitamins and minerals are also required to perform specific cellular functions, boost the immune system and support growth and development. Chapter 20 covers the newly emerging field of nutrigenomics: nurturing of genotype and role in human health. The influence of genetic variation on nutrition by correlating gene expression or single-nucleotide polymorphism (SNP) with a nutrient's absorption, metabolism, elimination or biological effects and to develop rational means to optimize nutrition, with respect to subject's genotype is known as nutrigenomics. It is the application of high-throughput genomic tools in nutrition research to provide methods and tools for disease preventing and health promoting phytochemicals/phytonutrients that match their lifestyles, cultures and genetics, which is determined by the specific demands of genetic signature and perfectly balances the macro- and micronutrient needs. Nutrigenomics is the emerging face of nutrition and phytonutrients that provide the necessary stepping stones to achieve the ambitious goal of optimizing an individual's health via nutritional intervention.

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Dhan Prakash
Girish Sharma

Contents

1 Phytochemicals of Nutraceutical Importance: Do They Defend Against Diseases?

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1.1 Introduction

The word 'nutraceuticals', coined by Dr Stephen de Felice, is derived from the words 'nutrition' and 'pharmaceutical', and is a food or food product that provides health and medical benefits, including the prevention and treatment of disease (Biesalski, 2001). A potential nutraceutical is one that holds a promise of a particular health or medical benefit; such a potential nutraceutical only becomes an established one after there are sufficient clinical data to demonstrate such a benefit (Pandey *et al.*, 2010). Therefore, a nutraceutical is exhibited to have a physiological benefit or provide protection against chronic disease. Such products may range from isolated nutrients, dietary supplements and specific diets to genetically engineered foods, herbal products, and processed foods such as cereals, soups and beverages. Their bioactive ingredients, the phytochemicals, sustain or promote health and occur at the crossroads of the food and pharmaceutical industries. Such substances may range from isolated nutrients, dietary supplements and specific diets to genetically engineered designer foods, herbal products, processed foods and beverages (Kalra, 2003; Prakash *et al.*, 2004). Chemically the nutraceuticals may be classified as isoprenoid derivatives (terpenoids, carotenoids, saponins, tocotrienols, tocopherols, terpenes), phenolic compounds (cumarins, tannins, lignins, anthocyanins, isoflavones, flavonones, flavonoids), carbohydrate derivatives (ascorbic acid, oligosaccharides, non-starch polysaccharides), fatty acid and structural lipids (n-3 PUFA, CLA, MUFA, sphingolipids, lecithins), amino acid derivatives (amino acids, allyl-S compounds, capsaicinoids, isothiocyanates, indoles, folate, choline), microbes (probiotics, prebiotics) and minerals (Ca, Zn, Cu, K, Se) (Sharma, 2009). They play a crucial role in maintaining optimal immune response, such that deficient or excessive intakes can have negative impacts on health. Around the world, governing bodies have accepted nutraceuticals as possible nutraceutical therapy in mainstream medical education and health. The healthcare industry demonstrated the shift of a growing population from medical treatment of cancer towards non-prescription nutraceuticals as self-medication in cancer management and prevention.

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The growing awareness of nutraceutical benefits and shift of healthcare economics in favour of nutraceuticals brought nutraceutical medicine into the spotlight of government health policy on the systematic use of nutraceuticals in prevention and/or control of various chronic diseases (Sharma, 2009).

The recent notion of 'customized' or 'personalized' medicine and diet is being advocated widely to the field of nutrition that can be used to delay the onset of disease and to sustain optimum human health (Dijsselbloem *et al.*, 2004; Kaput and Rodriguez, 2004). Dietary intake of phytochemicals may promote health benefits, protecting against chronic degenerative disorders, such as cancer, cardiovascular and neurodegenerative diseases. The majority of foods, such as whole grains, beans, fruits, vegetables and herbs, contain phytochemicals (Table 1.1). Among these, fruits and vegetables are significant sources of phytochemicals. These phytochemicals, either alone or in combination, have tremendous therapeutic potential in curing various ailments. Phytochemicals with nutraceutical properties present in food are of enormous significance due to their beneficial effects on human health since they offer protection against numerous diseases or disorders such as cancers, coronary heart disease, diabetes, high blood pressure, inflammation, microbial, viral and parasitic infections, psychotic diseases, spasmodic conditions, ulcers, etc. (Fig. 1.1). The National Cancer Institute has emphasized alternative methods of cancer prevention as public awareness by focusing mainly on lifestyle, eating habits, prevention and control care measures (Sharma, 2009). The major nutraceuticals were reviewed and reported as vitamins and minerals, phytochemicals. The vitamins A, B_6, B_{12}, D, E, folate have been reported as anticancer, immune-protective and reducing cancer risk in the population at risk of cancer and individuals who used self-medication (Holick, 2008; Milner, 2008; Zhang *et al.*, 2008).

Epidemiological and animal studies suggest that the regular consumption of fruits, vegetables and whole grains reduces the risk of chronic diseases associated with oxidative damage (Kris-Etherton *et al.*, 2002; Scalbert *et al.*, 2005; Cieslik *et al.*, 2006). Carotenoids, tocopherols, ascorbates, lipoic acids and polyphenols are strong natural antioxidants with free radical scavenging activity. Endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase, glutathione peroxidase, glutathione reductase, minerals such as Se, Mn, Cu, Zn, vitamins A, C and E, carotenoids, limonoids and polyphenols exert synergistic actions in scavenging free radicals. Synthetic antioxidants such as butylated hydroxy anisole (BHA) and butylated hydroxy toluene (BHT) play a useful role in the food and pharmaceutical industries (Kondratyuk and Pezzuto, 2004). The natural antioxidant system is mainly classified into two categories, namely *in vitro* and *in vivo* antioxidants.

The majority of the achievement of nutraceuticals is based on self-prescription and own individual experiences. However, it is difficult to realize the phenomenal benefits of nutraceuticals unless controlled clinical trials support the evidence and facts of nutraceutical preventive therapeutic efficacy (Sharma, 2009). This chapter summarizes the evidence for protective and health-beneficial effects of phytochemicals, which have the potential of being incorporated into foods or food supplements as nutraceuticals, or into pharmaceuticals, and to propose implications of the explosion in information for the future development, discovery and use of phytochemicals as nutraceuticals. Although nutraceuticals have significant promise in the promotion of human health and disease prevention, health professionals, nutritionists and regulatory toxicologists should strategically work to plan appropriate regulation to provide the ultimate health and therapeutic benefits to mankind. In this context, long-term clinical studies would be required to scientifically validate the nutraceuticals in various medical conditions. The interaction of nutraceuticals with food and drugs is another area that should be taken into consideration. The effect of different processing methods on the biological availability and effectiveness of nutraceuticals remains to be determined. Similar to drugs, there should also be stringent regulatory controls for nutraceuticals.

Table 1.1. Phytochemicals of nutraceutical importance, their sources and health benefits.

Phytochemicals	Source plant	Health benefits
α-Linolenic acid (ALA)	Flaxseed	Cancer preventive, reduce risk of coronary heart disease
Allicin	Garlic, onion	Antibacterial, anticancer, antifungal, anti-inflammatory, chemopreventive, hepatoprotective, hypolipidaemic, hypotensive and neuroprotective
Anthocyanins	Blackberry, cherry, orange, purple maize, raspberry, red grape	Anti-allergic, anti-inflammatory, antioxidants and pigments
Apigenin	Apple, artichoke, basil, celery, cherry, grape, nuts, parsley	Anti-inflammatory, antioxidant, antispasmodic, chemopreventive, induce apoptosis and inhibits breast and ovarian cancers
Caffeic acid	Artichoke, pear, basil, oregano	Anti-inflammatory, antifatigue and antistress properties
Carotene	Carrots, leafy greens and red, orange and yellow vegetables, pumpkin	Anticarcinogenic, enhances release of immunogenic cytokines IL-1 and TNF-alpha, provide cornea protection against UV light, stimulate DNA repair enzymes
Catechins	Tea	Antioxidant, CNS stimulant and diuretic
Curcumin	Turmeric	Antihypertensive, anti-inflammatory, antioxidant and cancer preventive
Diosgenin	Fenugreek seeds	Hypolipidaemic
Ellagic acid	Cranberry, grape, pecan, pomegranate, raspberry, strawberry, walnut	Anticancer and antioxidant
Ferulic acid	Oats, rice, orange, pineapple, groundnut	Protects against cancer, bone degeneration, menopausal symptoms (hot flushes)
Gallic acid	Tea, mango, strawberry, soy	Cytotoxic and antioxidative activities, antileukemic, antioxidant, anticancer, antineoplastic, anti-inflammatory, antidiabetic
Genistein	Lucerne sprouts, red clover, chickpea, groundnut, soybean	Acts as a phytoestrogen, antioxidant, anticancer agent, heart health and helps people with metabolic syndrome
Lutein	Kale, spinach, red pepper, mango, papaya, kiwi, peach, squash, honeydew melon, plum, avocado	Absorbs damaging blue light, protects against colon cancer

Continued

Table 1.1. Continued.

Phytochemicals	Source plant	Health benefits
Lycopene	Apricot, papaya, pink guava, tomato, watermelon	Lowers risk of atherosclerosis and prostate cancer
Momorbicin	Karela (bitter gourd)	Antidiabetic
Myristicin	Nutmeg	Hypolipidaemic
Piperine	Pepper	Aeromatic, analgesic, hepatoprotective and stomachic
Quercetin	Red onion, buckwheat, red grape, green tea, apple skin	Strong antioxidant, reduces LDL oxidation, vasodilator and blood thinner
Resveratrol	Blueberry, groundnut, red grape and red wine	Antioxidant, prevents ageing, cancer, diabetes and heart diseases
Rutin	Asparagus, buckwheat and citrus fruits	Strengthens capillary walls
Silymarin	Milk thistle (*Silybum marianum*)	Protects from UVB-induced carcinogenesis and hepatoprotective
Stigmasterol	Soybean	Anticancer, hypolipidaemic, prevention of osteoporosis
Sulforaphane, glucosinolates	Broccoli sprouts, cabbage, cauliflower, collards, cruciferous vegetables, kale, radish, turnip	Antioxidant, prevents DNA damage, reduces risk of breast and prostate cancers
Ursolic acid	Apple, basil, cranberry, lavender, oregano, rosemary	Anti-inflammatory, antimicrobial and antitumour
Withaferin, withanolides	*Withania somnifera*	Anticancer and immunomodulator
Zingiberene	Ginger	Antibacterial, antifungal, carminative and in treatment of dizziness

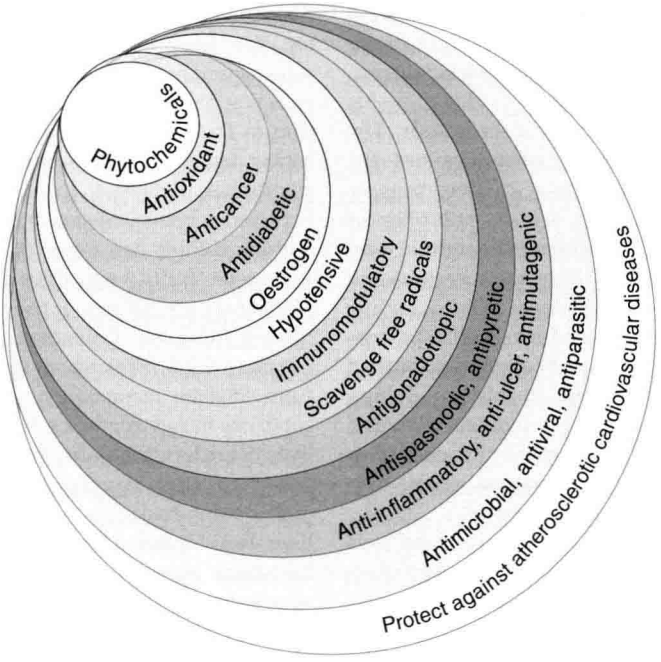

Fig. 1.1. Some important therapeutic properties of phytochemicals.

1.2 Phytochemicals and Their Health Benefits

1.2.1 Polyphenols

Polyphenols are naturally occurring compounds found largely in fruits, vegetables, cereals and beverages. Legumes and chocolate also contribute to the polyphenolic intake. These molecules are secondary metabolites of plants and are generally involved in defence against ultraviolet radiation or aggression by pathogens. Basic researches and epidemiological studies have shown the inverse association between risk of degenerative diseases and intake of a diet rich in polyphenols. The epidemiological studies provide convincing evidence that a diet rich in antioxidants is associated with a lower incidence of degenerative diseases. The major sources of dietary polyphenols are cereals, legumes (barley, maize, nuts, oats, rice, sorghum, wheat, beans and pulses), oilseeds (rapeseed, canola, flaxseed and olive seeds), fruits, vegetables and beverages (fruit juices, tea, coffee, cocoa, beer and wine) (Kaul and Kapoor, 2001; Scalbert *et al.*, 2005; Cieslik *et al.*, 2006; Katalinic *et al.*, 2006; Prakash and Kumar, 2011). Fruits such as apple, grape, pear, cherry and various berries contain up to 200–300 mg polyphenols 100 g^{-1} fresh weights. Similarly, a glass of red wine or a cup of coffee or tea contains about 100 mg polyphenols. Their total dietary intake may be about 1 g day^{-1}, which is about ten times higher than that of vitamin C and 100 times higher than those of vitamin E and carotenoids (Packer and Weber, 2001; Scalbert *et al.*, 2005).

Plant polyphenols are secondary metabolites that are broadly distributed in higher plants. Their unique characteristics are water solubility, intermolecular complexation and antioxidant properties. They are classified as condensed proanthocyanidins, galloyl and hexahydroxydiphenoyl esters and derivatives, or tannins. Polyphenols historically have been considered as antinutrients by nutritionists, because some, e.g. tannins, have adverse effects such as decreasing the activities of digestive enzymes, energy, protein and amino

acid availabilities, mineral uptake and having other toxic effects. Detection of the antioxidant activities of many polyphenols has reunited opinion toward the health benefits provided by many of these compounds. The most important dietary phenolics are the phenolic acids (including hydroxybenzoic and hydroxycinnamic acids), polyphenols (hydrolysable and condensed tannins) and flavonoids, the latter being the most studied group. Phenols protect plants from oxidative damage. They have also been studied extensively as antioxidant protectants for human beings and play a beneficial role in reducing the risk of coronary heart disease, diabetes, hypertension and some types of cancer (Gee and Johnson, 2001; Willcox *et al.*, 2004; Arts and Hollman, 2005; Andjelkovic *et al.*, 2006).

The chief constituents of tea polyphenols are flavonols (catechin, epicatechin, catechin-gallate and epigallocatechin-gallate), flavonols (quercetin, kaempferol and their glycosides), flavones (vitexin, isovitexin) and phenolic acids (gallic acid, chlorogenic acid). They constitute up to 30% of the dry weight of green leaves and from 9 to 10% of the dry weight of black tea leaves. Ferulic acid is associated with dietary fibre linked with hemicellulose of the cell wall by means of ester bonds. Caffeic acid in the form of caffeoyl esters and cumaric acids are common in apples, pears and grapes. Additionally, apples and pears are rich in chlorogenic acid and grapes in gallic acid. Apples contain high levels of quercetin among fruits. Grain-derived products are especially significant in human diet as they have higher concentration of phenolic acids in the outer layers of kernel that constitute the bran. Most of the phenolic acid derivatives are hydrolysable tannins and are usually esterified with glucose. Citrus fruits are major sources of flavonones and hesperidin is found in abundance (120–250 mg l^{-1}) in orange juice.

Quercetin occurs in its glycosylated form as rutin in fruits and vegetables and onions are a particularly rich source (Anagnostopoulou *et al.*, 2006; Prakash *et al.*, 2007a; Singh *et al.*, 2009). Anthocyanins are pigments of fruits such as cherries, plums, strawberries, raspberries, blackberries and red currant (Table 1.1) and their content varies from 0.15 to 4.5 mg g^{-1} in fresh berries. Occurrence of some of the flavonoids is restricted to a few foodstuffs; e.g. the main source of isoflavonoids is soy, which contain ~1 mg g^{-1} of genistein and daidzein that have received considerable attention due to their suggested role in prevention of cancer and osteoporosis. People who consume traditional diets rich in soy and tea rarely experience breast, uterus and prostate cancer. Although there is a range of potentially antimutagenic fruits, vegetables and cereals, their intake is generally below the level essential to protect from various mutagens (Dillard and German, 2000; Prakash *et al.*, 2004). Extracts from *Silybum marianum* have been used for centuries in folk medicine for the treatment of liver disorders. Silibinin, the main flavolignan occurring in the flavonoids mixture silymarin of this plant, had shown positive effects on the liver. Besides being hepatoprotective, silibinin has been extensively evidenced to induce apoptosis, reduce and/or inhibit cell proliferation and tumour angiogenesis in human lung, bladder and prostate cancer models (Sharma *et al.*, 2003; Singh *et al.*, 2003, 2004, 2008a, b). Kolaviron from seeds of *Garcinia kolu* and hispidulin from *Buccuris frimeru* have also been reported as hepatoprotective (Kris-Etherton *et al.*, 2002; Cai *et al.*, 2004).

Flavonoids

Flavonoids comprise the most common group of plant polyphenols. Flavonoids are a subclass of plant phenols, which includes the minor flavonoids (flavanones and dihydroflavonols), flavones and flavonols. Flavonols are the most ubiquitous flavonoids in food. Quercetin and kaempferol are the main representatives of this group. They are generally present at relatively low concentrations of about 15–30 mg kg^{-1} fresh weight. Onions, curly kale, leeks, broccoli and blueberries are rich sources of flavonols. Flavanones are found in tomatoes and certain aromatic plants such as mint (*Mentha piperita*), but they are present in high concentrations only in citrus fruits. The main flavanones are naringenin in grapefruit, hesperetin in oranges and eriodictyol in lemons. A vast amount of recent literature proposes that the stilbenes provide beneficial health effects (Pandey and Rizvi, 2009). Recent studies indicate that like other