Invited article

Herbs that heal: Natural panacea for health promotion

Kanti Bhooshan Pandey
CSIR-Central Salt and Marine Chemicals Research Institute, Bhavnagar-364002, Gujarat, India

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Abstract

Kitchen has always been one of the most attractive places for health related studies since food connects health and wellness. Epidemiological and clinical studies have repeatedly shown the health promoting properties of culinary herbs. Present article deals with description of healing properties of curcumin (*Curcuma longa* L.) garlic (*Allium sativum* L.) and ginger (*Zingiber officinale* Roscoe), the major constituents of spices used in kitchen.

Key words: Herbs, spices, medicine, health, disease

1. Introduction

Since ancient times, herbs have been used by humans as food and to treat health ailments. A growing body of evidence has demonstrated that aromatic herbs used as spices possess potent therapeutic properties which may provide significant protection against many deleterious human diseases (Viuda-Martos et al., 2010; Singh et al., 2012; Yashin et al., 2017; Rakhi et al., 2018). Sumerians were the first, who were documented to use thyme (*Tymus vulgaris*) for its health promoting effects date back to 5000 BC (Viuda-Martos et al., 2010). In later centuries, Indians and Egyptians are mentioned to use garlic, ginger, curcumin, coriander and many other herbs as spices in their food, the trend was followed by other part of the world (Bellamy and Pfister, 1992). Now, spices have been established as incumbent part of human food and are used in all the cultures in more or less amount. An array of evidence present in the literature referred by experimental and clinical studies, describes health promoting effects of these culinary herbs (Biradar, 2015; Yashin et al., 2017; Rakhi et al., 2018). Spices have been reported to impart taste, flavor, improve digestive capability and prevent spoilage of the food (Viuda-Martos et al., 2010).

Recently, interest on herbal medication to protect the health has increased all over the world due to everlasting serious side effects of synthetic drugs (Manoharachary and Nagaraju, 2016; Mohammad et al., 2017; Rakhi et al., 2018). Role of diet in health and diseases has already been established (Pandey and Rizvi, 2009; Rajeshwari et al., 2014; Pandey, 2017; Owen and Corfe, 2017), however, concept of adequate nutrition is still been a topic of debate and research which includes the components, type and quantity of food (Guldiken et al., 2018).

Increasing culinary and health related beneficial effects of spices have attracted the researchers and food and pharma industries to explore the medicinal properties of the spices, followed by investigation of bioactive compounds present in them and to their bioavailabilities in order to develop potential drugs to cure health ailments. Present article deals with description of healing properties of curcumin, garlic and ginger, the major constituents of spices used in kitchen.

2. Curcumin (*Curcuma longa* L.)

Curcumin is a bioactive yellow component of turmeric (*Curcuma longa* L.), an herb with tuberous shoot and yellow flowers. This tropical plant belongs to the family Zingerberaceae whose growth and nutritional potency depends upon the type of the soil and environment where it grows (Singh et al., 2016; Kocaadam and Aanlier, 2017). The analytical studies have shown that turmeric powder obtained from a tropical healthy plant contains carbohydrate as major part, followed by protein and fat (Prasad et al., 2014). Curcumin is a lipophilic polyphenolic compound which constitutes about 5% of the turmeric powder in which curcumin shares lager percentage (77%), followed by demethoxycurcumin (DMC); approximately 17% and 3% by bidemethoxycurcumin (BDMC) (Goel et al., 2008). Chemically, curcumin (*C*_{16}*H*_{12}*O*_{6}) is represented as 1,7-bis-(4-hydroxy-3-methoxyphenyl)-hepta-1,6-diene-3,5-dione or dipheruloylmethane (Deogade and Ghathe, 2015).

Being lipophilic in nature, the bioavailability of curcumin is low which limits the *in vivo* biological activities of this phenolic compound. Recent experiments have reported that use of curcumin nanoparticles and/or ligand bound delivery of curcumin have enhanced its bioavailability and, thus *in vivo* effects (Devassy et al., 2015; Rakotoarisoa and Angelova, 2018). It has been documented that curcumin also possess biological activities, through its metabolites which includes dihydrocurcumin (DHC), tetrahydrocurcumin (THC), octahydrocurcumin (OHC), hexahydrocurcumin (HHC), curcumin gluchonide, and curcumin sulfate (Prasad et al., 2014). In ancient days, curcumin was mainly used for color but later years after recognition of its therapeutic properties, it has become an essential part of kitchen.

2.1 Healing properties

In Ayurveda and conventional Chinese medicinal system, curcumin has been used to treat a wide range of disorders and promote health...
(Singh et al., 2016; Kocaadam and Aanlier, 2017; Kim and Clifton, 2018). In mid-nineteenth century, after its extraction by Vogel and Pelletier, curcumin was scientifically stated as the substance carrying antibacterial properties (Kocaadam and Aanlier, 2017). Curcumin was then reported to be effective against wide range of bacteria including Mycobacterium tuberculosis and Salmonella paratyphi (Moghadamtousi et al., 2014). In 20th century, much work was carried out in different laboratories on different model systems including humans in different conditions. The conclusive remarks of most of the studies were that curcumin has potent therapeutic effects against severe human pathologies including auto-immune disorders and metabolic diseases via modulation of molecular targets/ processes (Pandey et al., 2011; Singh et al., 2016; Kim and Clifton, 2018).

2.2 Anticancer property

Anticancer effect is one of the most explored biological properties of curcumin. This magical compound has been reported to be effective against colon, pancreas, breast, lung, blood, and liver cancer (Prasad et al., 2014; Barati et al., 2019). Clinical studies and human trials have documented the protective activity of curcumin against many phases of carcinogenesis: initiation, progression, invasion and metastasis (Anand et al., 2008; Barati et al., 2019).

Experimental evidence has shown that curcumin suppress growth of cancer cells via multiple pathways which may incorporate caspase activation, tumor suppression, death-receptor pathway, cell survival and modulation of various protein kinases including adenosine monophosphate-activated protein kinase (AMPK) (Kocaadam and Aanlier, 2017; Lyons and Roche, 2018). In addition to direct action on carcinogenesis, curcumin has been reported to improve the effectiveness of radiotherapy, thus enhances the chance of curability and survival (Akpolat et al., 2010).

2.3 Protection of cardiovascular diseases

Anti-inflammatory and antioxidant properties of curcumin enable it to be stand in the front queue of the herbal agents used in therapies of cardio-related vascular disorders. Curcumin has been documented to enhance the expression of heme oxygenase-1 (HO-1) by motivating NF-κB-dependent antioxidant response and to suppress tumor necrosis factor alpha (TNF-α) in smooth muscle cells and thus activates the expression of p21 mediated by HO-1 (Pae et al., 2007; Kocaadam and Aanlier, 2017). Over expression of JAK2/STAT3 signal pathway is the mechanism by which curcumin has been found to prevent ischemia (Duan et al., 2012). Administration of curcumin has shown to lower the risk of development of coronary diseases by diminishing the serum triglyceride (TG), low-density lipoprotein (LDL) and very low-density lipoprotein (VLDL) cholesterol (Mirzabeigia et al., 2015). Hypertension and hyperlipidemia are reported as the other major culprits behind cardiac arrest; a diet rich in curcumin has been found to be protective against these biomarkers, thus lowers the threaten to life (Panahi et al., 2018).

2.4 Antidiabetes and antiobesity properties

Diabetes is a metabolic disorder which affects almost all the vital organs of the body. Functioning of brain, kidneys, liver, heart and eyes badly compromised in hyperglycemia (Tiwari et al., 2013; Nabavi et al., 2015). Adequate dose of curcumin has been documented to prevent the condition of hyperglycemia by multiple mechanisms and thus prevents the development of diabetes (Shehzad and Lee, 2010; Nabavi et al., 2015). Recent studies have shown that curcumin reduces sustained blood glucose level by increasing expression of various glucose transporters (GLUTs), decreasing glucose hepatic regeneration and increasing uptake of glucose by cells (Nabavi et al., 2015). Curcumin has also been reported to protect insulin resistance and enhance insulin sensitivity (Ghorbani et al., 2014). Induction of HO-1 gene and potent radical activities are also considered as important mechanisms by which curcumin prevents the complications associated with diabetes (Deogate and Ghanie, 2015).

Curcumin has been found to be effective against obesity since its supplementation suppressed mitogen activated protein kinase (MAPK) and other kinases which are regulated by signals and are directly associated with cell differentiation and genesis of adipocytes (Ahn et al., 2010). Elevation in adiponectin expression due to treatment of curcumin promotes the antiobesity property of this yellow compound since adiponectin prevents genesis of obesity through suppressing NF-κB activity (Ahn et al., 2010; Nabavi et al., 2015).

2.5 Prevention of neuro-disorders and ageing

Time dependent degradation in activities and alertness is ageing which ultimately results in death. Ageing is scientifically considered as a disease (Paney and Rizvi, 2010). Malfunctioned neuronal activities are the major reason to promote ageing and other associated pathologies. Studies have documented that curcumin possess the potential that could involve to prevent age associated events and to increase healthy life span (Sarker and Franks, 2018). Strong anti-oxidative, anti-inflammatory activities of curcumin are proposed to restore the protein homeostasis, suppress inflammation and gene mutations which are reported to play significant role in development and progression of neurodisorders, followed by ageing (Nabini et al., 2011; Sarker and Franks, 2018). Curcumin has been documented to improve cognitive functions through reducing deterioration of neurons and formation of α-amyloid plaques and microglia (Mishra and Panalivelu, 2008). It has also been reported that curcumin possesses remarkable protective effect against degradation of myelin sheath and maintaining dopamine levels in striatum (Tegenge et al., 2014).

2.6 Others

Besides described healing properties, use of curcumin is documented in therapy of many skin ailments such as dermatitis, scleroderma and psoriasis (Panahi et al., 2019). In traditional Indian medical system, use of curcumin to make the skin wrinkle-free and make it glow is one of the most frequent practices (Prasad et al., 2014). Scavenging the free radicals and prevention of inflammation by inhibiting NF-xB are the reported mechanisms by which curcumin may protect the skin from being damaged (Prasad et al., 2014; Panahi et al., 2019). Curative effects against gastric ulcers, induction of gastric juice, prevention against inflammatory bowel disease and improving digestion are the other reported healing effects of curcumin. In addition, curcumin has also been reported to be beneficial in asthma and other allergies (Shehzad and Lee, 2010). Agencies deputed for certification of food and drug have accepted curcumin as a generally recognized safe compound to administer for a good health (Kocaadam and Aanlier, 2017).
3. Garlic (*Allium sativum* L.)

Garlic (*Allium sativum* L.) is one of the most frequently used herbal spices in the kitchen. It is a bulbous herb having a powerful aroma and pungent taste. Garlic contains a variety of bioactive constituents including sulfur compounds such as alliin, allicin, ajoene, allylpropyl disulfide, diallyl disulfide (DADS), diallyltrimethylsulfide (DATS), S-allylcysteine (SAC); peroxidases and alliinase like enzyme, amino acids and many important trace elements like Se, Ge and Te (Rana et al., 2011; Adaki et al., 2014). Interestingly, quantity of sulfur compounds in garlic is higher than other *Allium* ssp. (Amagase et al., 2001). There is evidence that excessive amount of sulfur compounds in garlic are mainly responsible for the pungent taste and therapeutic properties associated with consumption of garlic (Petropoulos et al., 2017).

The garlic constituents have shown a higher bioavailability which ranges from 10 min (alliin) to 120 min (vinyldithiins) in reaching peak serum concentration (Egen-Schwind et al., 1992). The persistence of these compounds is also better than other same species compounds; alliin persists for about 6 h whereas persistence of vinyldithiins is reported up to four days. Clinical and human trials have shown that garlic constituents are absorbed up to 98% when taken orally (Lachmann et al., 2014; Amagase et al., 2001; Rana et al., 2011).

3.1 Healing properties

Garlic has historically been used for treatment of many deleterious diseases and to promote good health. In many parts of the world, garlic is frequently used to treat aches and pains, leprosy, diarrhea, infections, dandruff, respiratory disorders, fatigue and blood pressure disorders (Adaki et al., 2014; Boringhaus et al., 2014; Miraghaijani et al., 2018). After demonstration of antiseptic property of garlic by Louise Pasteur in 1858, the scientific studies for exploration of its medicinal properties, extraction of bioactive compounds and development of remedy drugs of garlic origin gained the attention (Rana et al., 2011).

3.2 Protection of cardiovascular diseases

Cardiovascular protective effect is the most notable therapeutic property of garlic components. Human trials have documented that garlic prevents vascular disorders by means of managing lipid profile of blood, controlling blood pressures, inhibiting platelet aggregation and by modulating fibrinolytic activity (Adaki et al., 2014; Karagodin et al., 2016). Experimental studies have also reported that supplementation of garlic extract lowered the blood cholesterol level, improved blood circulation and, thus delayed the progression of atherosclerosis (Karagodin et al., 2016). There are reports that claim that consumption of garlic or a diet rich in garlic can reduce the plaque deposits in the arteries and, thus may provide a natural way to prevent angina and atherosclerosis (Borek, 2006).

Hypertension is one of the major factors involved behind development of many cardio-related disorders which affects the life in several ways (Li et al., 2013). Epidemiological and laboratory studies have proven that short term supplementation of garlic elicits protective effect in hypertensive patients; lowered the elevated levels of oxidative stressors and declined the systolic and diastolic blood pressures (Borek, 2006; Lee et al., 2013). Ingestion of garlic extract has also been showed the protective effect against biochemical alterations in patients with atherosclerosis (Campbell et al., 2001; Karagodin et al., 2016).

3.3 Anticancer property

Epidemiological studies have shown that supplementation of garlic reduced the development and progression of tumor and cancer. Garlic has been shown to be effective against colon, lung, stomach, skin and breast cancer (Adaki et al., 2014; Nicastro et al., 2015; Miraghaijani et al., 2018). Garlic constituents have been found to influence enzymes of phase I and phase II which are involved in bioactivation as well as removal of carcinogens (Manson et al., 1997). Studies have also provided experimental evidence that organosulfur compounds of garlic suppress the NAD(P)H:quinone oxidoreductase, cyclooxygenase and lipoxygenase that account for lower incidence of carcinogenesis (Roy and Kulkarni, 1999). Experimental study has shown that intra-peritoneal injection of DADS was effective in treatment of colon cancer in mice (Sundaram and Milner, 1996). Other major constituent of garlic; DATS has been found to prevent cell proliferation by inducing programmed cell death through over expression of extra cellular signal regulated kinase and inhibition of Bel-2 protein (Xiao et al., 2004). The derivatives of garlic are found to be effective in cancer treatment since they modulate the mechanisms that involve in cancer development such as formation of DNA adduct, mutagenesis, cell proliferation, damage by reactive oxygen species (ROS), formation of new blood vessels and apoptosis and, thus establish garlic as one of the most potent herbal agent against most types of cancer (Nicastro et al., 2015; Miraghaijani et al., 2018).

3.4 Immune promotive and antiaging effect

Recent data on therapeutic effects of garlic suggest that sulfur compounds and trace elements present in garlic including Se, have immune stimulating property which prevents the body from intra and extra cellular stressors and infections and, thus promotes healthy life-span (Rahman et al., 2003; Kim, 2016). Garlic has been reported to improve NK cells functions and restore the age-related cognitive behavior in AIDS patients (Lamm and Riggs, 2001). There are experimental evidence that garlic supplementation increases antibody production, lymphocyte proliferation and generation of cytokinins which are used in antitumor response (Adaki et al., 2014; Nicastro et al., 2015). Garlic has been shown to enhance serum antioxidant level by activating expression of inherent enzymatic defense systems such as glutathione peroxidase and superoxide dismutase (SOD) in dose dependent manner and to inhibit lipid peroxidation and inflammatory prostaglandins (Rahman et al., 2003; Capasso, 2013). The antioxidant potential of garlic was comparable to the established antioxidants such as ascorbic acid (Vitamin C) and α-tocopherol (Vitamin E); effect of 1 mg garlic was equivalent to 30 nmol vitamin C or 3.6 nmol vitamin E (Lewin and Popev, 1994).

3.5 Others

There are other health areas where garlic supplementation/injection has shown beneficial effects. Some antecedent studies have described antimicrobial properties of garlic and have shown that garlic can inhibit persistence yeast infections and may be useful in treating ear infections (Chung et al., 2007). In African countries, garlic is frequently used in treatment of dysentery (Peirce, 1999). In addition to the mentioned properties, garlic remedies are used to treat various respiratory tract infections, cough and cold and influenza (Abdullah, 2000); irrespective to prevent/treat the diseases after their development, garlic or its extracts have also been used to improve overall health. Potential antioxidant, anti-
inflammatory and radical scavenging properties of garlic establish it as a health tonic of herbal origin. The fresh garlic sulfur compounds have shown higher antioxidant potential than aged garlic (Jeong et al., 2016).

4. Ginger (Zingiber officinale Roscoe)

Ginger (Zingiber officinale Roscoe) of family Zingiberaceae, is a perennial herb whose rhizome is used in culinary and medicinal purposes. Over a hundred compounds have been reported to be present in fresh rhizome of ginger including protein, fat, carbohydrate and essential oils (Zadeh and Kor, 2014). Ginger is rich in vitamins especially in B complexes, C and fiber content (Mashhadi et al., 2013). Besides this, ginger possesses several bioactive compounds such as gingerol, shogaol, paradol and zingerone, among which gingerol, biochemically denoted as [6]-gingerol is explored more for biological activities than others. Biochemical analysis of fresh rhizome of ginger have shown that mainly [6]-gingerol is involved in medicinal and therapeutic properties of ginger (Mashhadi et al., 2013; Zadeh and Kor, 2014; de Lima et al., 2018).

4.1 Healing properties

Over twenty five centuries, ginger has been used as a medicinal herb to treat many health disorders and promote good health (de Lima et al., 2018). Initially, it was used to treat nausea and to warm body in winter season but later on, it was used to prevent inflammatory diseases and pain (Ali et al., 2008). Recent studies and human trials have shown that ginger or ginger rich diets have potential to prevent the diseases and promote good health.

4.2 Anticancer property

Studies have provided significant evidence that ginger elicits potent anticancer and antitumor activities (Shukla and Singhm 2007; de Lima et al., 2018). Though, ginger has exhibited preventive properties against many types of cancer including ovarian, liver, skin, breast, and prostate cancer, but its effect against colon cancer is more remarkably described (Ishiguro et al., 2007; Hung et al., 2009; de Lima et al., 2018). Study performed to investigate the potency of ginger in prevention of development and progression of colon cancer has documented that treatment of ginger over expressed the inherent antioxidant enzymes such as glutathione peroxidase, and glutathione, peroxidation of lipids and activated the NF-κB in human epidermoid carcinoma cells (Ishiguro et al., 2009). There are experimental evidence that ginger has prevented the proliferation of human epidermoid carcinoma cells (Nigam et al., 2009). There are experimental evidence that ginger has remarkable effect in prevention of pancreatic carcinoma cells, breast and prostate cancer via mediating the signaling pathways, activating protein caspases involved in programmed cell death and via inhibiting cell adhesion invasion motility (Mashhadi et al., 2013; Walczak, 2017; de Lima et al., 2018).

4.3 Cardiovascular protection

Ginger is reported to provide overall protection against cardio-related health disorders. Ginger has been reported to dilute the blood and to improve blood circulation via its stimulating effect of muscles of heart (Kulczyński and Gramza-Michasowska, 2016; Wang et al., 2017). Both the activities are described to stimulate the cellular metabolic events, thus contributing to the relief of cramps and reduce hypertension (Wang et al., 2017). Ginger has been reported as excellent anticoagulant which reduces the clotting ability of blood by inhibiting the formation of pro-inflammatory prostaglandins (PGE2) and thromboxane (TBX2) (Ezzat et al., 2018). Consumption of ginger has been reported to lower the cholesterol level in blood even after intake of fat rich diet (Kulczyński and Gramza-Michasowska, 2016). Extract of ginger is found beneficial in lowering the blood pressure and relaxing blood vessels by mediating the blockade of calcium channels, thus reduces the chances of hypertension and stroke (Zadeh et al., 2014; Wang et al., 2017).

4.4 Prevention of ageing and induced complications

Ageing itself comes with informal invitation to various health complications. Unregulated generation of ROS, weaken defense systems and diminished plasma antioxidant potential damage various visceral vital organelles of the cells and make them malfunctioned (Pandey and Rizvi, 2010; Singh et al., 2016). Persistence condition of compromised state of cell physiology induces complications including hyperglycemia, kidney damage, neuro-complications and impaired cognitive function which ultimately result in ageing (Di Loreto and Murphy, 2015). Treatment of ginger has been reported to beneficial in most of the complications related with ageing and promoting the health (Hügel, 2015; Choi et al., 2018).

Plethora of reports available that claim that supplementation of ginger or ginger rich food significantly prevented oxidation of proteins and glutathione, peroxidation of lipids and activated the inherent antioxidant enzymes such as glutathione peroxidase, glutathione reductase, and glutathione S-transferase (Ahmed et al., 2008; Mashhadi et al., 2013). Ginger has elicited the activity to modulate the serum C-reactive protein levels and induction of SOD activities in renal problems to prevent the damage (Choi et al., 2017). Strong antioxidant and anti-inflammatory activities of ginger have been documented to involve in prevention of age induced complications (Mashhadi et al., 2013; Ezzat et al., 2018).

Experiments on induced diabetic rats have provided the evidence that ginger possesses the potency to regulate blood glucose level in liver cancer has been reported (Habib et al., 2008). Same effect was observed in prevention of ovarian cancer in which along with reducing the expression of NF-κB, ginger supplementation suppressed the secretion of VEGF and IL-8 (Rhode et al., 2007).

In continuation, anticancer effect of ginger was also reported in treatment of skin myeloma. Bioconstituent of ginger; gingerol prohibited the proliferation of human epidermoid carcinoma cells (Nigam et al., 2009). There are experimental evidence that ginger has remarkable effect in prevention of pancreatic carcinoma cells, breast and prostate cancer via mediating the signaling pathways, activating protein caspases involved in programmed cell death and via inhibiting cell adhesion invasion motility (Mashhadi et al., 2013; Walczak, 2017; de Lima et al., 2018).

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and improve lipid profile including managing LDL, VLDL, TG and HDL levels (Fuhrman et al., 2000; Bhandari et al., 2005). Besides this, supplementation of ginger has also been reported to stimulate the production, release and/or activity of insulin and lowered the body weight which is an important measure in prevention of development of hyperglycemia (Nammii et al., 2009; Heimes et al., 2009).

4.5 Prevention of gastrointestinal discomfort and others

Improving gastrointestinal process is the oldest documented healing property of ginger (Oso et al., 2013). A diet rich in ginger/ginger extract has been reported to stimulate digestion by increasing absorption, relieving constipation and flatulence (Oso et al., 2013; Zadeh et al., 2014). Ginger is documented as a strong preventive agent against motion sickness like dimenhydrates; administration of approximately 1 g ginger was remarkably effective in prevention of nausea and vomiting (Langner et al., 1998; Zadeh et al., 2014).

Other therapeutic, property of ginger is its toxic effects on microbes. There are reporting that ginger has ability to inhibit the multiplication of bacteria of colon that cause fermentation of undigested food which triggers flatulence, a major cause of development of piles (Lohsiriwat et al., 2010). Ginger supplementation counteracts the growth of Escherichia coli, Proteus spp, Staphylococci, Streptococci and Salmonella spp (Eliopoulos, 2007; Zadeh et al., 2014). Ginger juice has been shown inhibitory action against different species of fungi which cause skin diseases (Eliopoulos, 2007; Haque and Jantan, 2017).

5. Conclusion

Herbs are a simple way to add flavor and nutrition to foods. Both in vitro and in vivo studies have confirmed the therapeutic properties of curcumin, garlic and ginger, however studies have so far been need to be conducted to propose the precise recommendations of the reference doses that could guarantee the desired effects.

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