Spices as Functional Ingredient for Human Health

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Abstract—*India is the largest producer, consumer and exporter of spices in the world, contributing about 86% of the global spice production. Besides spices are being consumed in Indian households as coloring and flavoring agent; they have potential health promoting benefits. The primary bioactive components of commonly used spices (black pepper, cardamom, clove, cinnamon, cumin, fenugreek, ginger, star anise, turmeric) are flavonoids, phenolic acids, and carotenoids. Hence, spices are potential medicinal sources having anti-angiogenic, anti-bacterial, anti-carcinogenic, anti-diabetic, anti-flatulance, anti-fungal, anti-inflammatory, anti-mutagenic, anti-oxidant, anti-proliferative, anti-septic and anti-tumorigenic properties. Despite of versatile medicinal properties of spices, most of the people have a perception that consumption of spices may lead to obesity and diseases. Although it has been reported that excessive consumption of spices may favor the pathogenesis of gastric and duodenal ulcer; however proper intake of spices is proven to be beneficial for human health. So, this paper presents the uses of spices with a focus on its medicinal virtues that are experimentally evidenced.*

Keywords*: Spices, medicinal properties, anti-oxidant, anti-inflammatory, anti-carcinagonic*

1. INTRODUCTION

According World Health Organization about 80% of the world population is dependent upon medicinal plants and herbs for their healthcare needs. Spices have a significant role in human life. Tremendous research are carried out to investigate and develop novel products with food, pharmaceutical, cosmeceutical, nutraceutical and health care importance from natural sources like herbs and spices. Plant medicines are proven to have less side effects as compared to modern medicines [1]. Medicinal spices and herbs can also be used as food, oil and fiber plants and have always been grown for a range of purposes. Herbs differ from spice in that they are leafy portions of the plant. The best known use of spices in our everyday life is in food and cooking. In industries, their essential oils and oleoresins are used as a supplement to fruit and vegetable preservatives, flavorings, chocolates, cakes, alcoholic and non-alcoholic drinks, perfumes, insect repellents etc. This study reviews the uses of spices, with a focus on its medicinal importance.

2. SPICES: GENERAL DESCRIPTION

According to wiki, a spice is a seed, fruit, root, bark, berry, bud or other vegetable substance primarily used for flavoring, coloring or preserving food. The word spice comes from the Old French word “espice”, which became epice, and which came from the Latin root spec, which means "appearance, sort, and kind".

To develop a spice route numerous attempts had been made by traveling around India and China. Marco Polo’s explored Venice as the most important trade port in late 13th Century and it remained until about 1498. The Portuguese explorer, Vasco de Gama, sailed around Africa’s Cape of Good Hope to reach Calicut, India. He returned with pepper, cinnamon, ginger and jewels, and also deals for the Portuguese to continue trade with India. From that time spice has been regarded as a valuable product for trade [2].

Since thousand years, spices have been used not only as flavoring and coloring agents, but also as food preservatives and folk medicines throughout the world. Many spices also have been reported as having digestive stimulant action, carminative action, antimicrobial, anti-inflammatory, anti-mutagenic, anti-carcinogenic potential, etc. [3]. In Indian house hold usually spicy flavor results from some common spice such as the use of garlic, ginger, chili peppers.

3. HEALTH BENEFITS

People form western countries have a tendency to use spices to produce more pleasing foods with reduced levels of fat, sugar and salt. Some spices are used more for imparting an attractive color to foods than for enhancing taste, e.g. turmeric and paprika. In addition to imparting flavor and taste, they possesses medicinal health benefit because of their antioxidant, anti-carcinogenic, anti-inflammatory and antibacterial properties. Spices are also used as a major component in preparation of alcoholic drinks and beverages.

3.1 Anti-oxidant

Apart from green tea, numerous spices are the most important targets in the search for natural antioxidants from the point of view of safety. The majority of antioxidant activity is due to

flavones, isoflavones, flavonoids, anthocyanin, coumarin lignans, catechins and isocatechins [4]. Spices have many anti-oxidants in varying amount like fruits and vegetables. Spices have high antioxidant concentrations that have the potential to inhibit the oxidation of low-density lipoprotein [5-6]. A study conducted by Tanabe et al., (2002) on comparison of phenolic compound of 22 commonly used spices and culinary herbs indicated that the total phenolic content ranged from 0.26 mg to 17.51 mg of gallic acid per gram fresh weight [6]. Black pepper is rich in glutathione peroxidase and glucose-6-phosphate dehydrogenase which are anti-oxidants [7]. Star anise contains phenolic compounds kaempferol, quercetin and their glycosides [8] whereas nutmeg contains lignans, eugenol, apinene, β-pinene, β-caryophyllene, p-cymene and carvacrol [9] which have anti-oxidant activity. Eugenol (a major compound of clove) inhibited 5-lipoxygenase and formation of leukotrienes in Human PMNL (Polymorphonuclear leucocyte) cells [10]. Antioxidants isolated from spices is listed in Table 1.

Table 1: Anti-oxidant components of common spices [11]

Spice	Antioxidants
Black pepper	Phenolic amides, flavonoids
Ginger	Gingerol
Tumeric	Curcumin
Red pepper	Capsaicin
Chilli pepper	Capsaicin, capsaicinol
Clove	Eugenol
Rosemary	Carnosic acid, carnosol, rosemarinic acid, rosmanol
Sage	Carnosol, carnosic acid, rosmanol, rosmarinic acid
Oregano	Derivatives of phenolic acid, flavonoids, tocopherols
Thyme	Carvacrol thymol, p-cymene, caryophyllene, carvone borneol
Marjoram	Flavanoides
Allspice	Pimentol

3.2 Anti-carcinogenic

There are certain spices which have a chemo-preventive effect against the early initiating stages of cancer. Spices possess anti-carcinogenic properties through certain phytochemicals and inhibit one or more of the stages of the cancer process (i.e. initiation, promotion, growth and metastases). Diallyl sulfide, a compound in garlic, is an efficient inhibitor of the phase I enzyme cytochrome P450 and significantly increases a variety of phase II enzymes, including glutathione S-transferase, quinone reductase and uridine diphosphate-glucuronosyl transferase, which are responsible for the detoxification of carcinogens [12]. Turmeric was found to have chemopreventive effects against cancers of the skin, fore stomach, liver and colon, and oral cancer in mice [13]. There is increasing attention to the possible positive effects of curcumin to Alzheimer's diseases (a heart disease), for which the sale of turmeric have grown tremendously in the last few years [29]**.**

Table 2 Anti-carcinogenic components of some spices [14]

Spices	Active components
Turmeric	Curcumin
Garlic	Allicin
Red chili	Capsaicin
Anise	Anethol, camphor, and fennel
Cloves	Eugenol
Cardamon	Limonene

3.3 Anti-inflammatory

Inflammation is a body response of harmful stimuli such as pathogens, damaged cells, irritants etc. by which that body part becomes red, hot, swollen and often gets painful. Cytokinin which are small secreted proteins released by cells have pathogenic pain by directly activating nociceptive sensory neurons [15]. Mueller *et al.* (2010) have experimented the anti-inflammatory potential of around 20 spices and found anti-inflammatory response in a LPS (Lipopolysaccharides)-stimulated macrophage model upon treatment with chili pepper, allspice, basil, bay leaves, black pepper, licorice, nutmeg, oregano, sage or thyme via reduction of IL6 (Interleukin 6) or TNF-α (Tumor necrosis factor- α) production, enhancement of IL-10 production, or reduction of expression of COX-2 (cyclooxygenase-2) or iNOS (nitric oxide synthase) [16]. Turmeric contains six different COX-2 inhibitors (the COX-2 enzyme speeds up the formation of substances that cause inflammation and pain, and causes tumor cells to grow) [17]. Cayenne contains a range of flavonoids and carotenoids – antioxidants that scavenge free radicals to protect against the cellular damage that leads to inflammation and disease [18]. The potent antioxidant 6-gingerol inhibits production of the free radical peroxynitrite that causes inflammation and pain [12]. Carnosic acid and carnosol are the chief anti-inflammatory molecules that give sage its health benefits and contribute to its flavor/aroma.

3.4 Anti-bacterial

Allicin present in garlic extract inhibited the growth and killed most of the organisms of oral bacteria [19]. Rath and Padhy (2014) have experimented in vitro antibacterial efficacy of 26 Indian spices against multidrug resistant urinary tract infecting bacteria out of which two spices i.e. *Cinnamomum zeylanicum* (Cinnamon) and *Curcuma longa* (turmeric) have potential for controlling all pathogens. Camphor, a bioactive compound in sage, kills bacteria and fungi [20].

3.5 Prevention of Cardio-vascular Diseases

Stevinson *et al.*, (2000) reported that intake of 600–900 mg of standardized garlic extract per day was associated with a modest decrease in serum cholesterol level i.e. 0.41 mmol/L [21]. Cinnamaldehyde, present in cinnamon inhibits the NF-kB (nuclear factor kappa-light-chain-enhancer of activated B cells) proteins, transcription factors for pro-inflammatory genes and genes involved in immune, growth, and cell death responses, and it prevents blood platelets from clumping – all

of which protect against heart disease [22]. Increase in High-density lipoprotein (HDL) cholesterol and a decrease in total serum cholesterol was found as a result of curcumin administration (500 mg/day for 7 days) [23].

3.6 Other Benefits

Apart from above advantages, spices are associated with some other benefits. Cardamon oil is used in cosmetics because of its cooling properties (Khalif *et al.*, 2008). Aruna and Baskaran (2010) made a comparative study on the levels of carotenoids lutein, zeaxanthin and β-carotene in Indian spices of nutritional and medicinal importance and found that Green chili contains more amounts of carotenoids which are responsible for preventing blindness due to retinol and lutein deficiency [25]. Cardamom contains bioactive compounds such as limonene, caffeic acid, 1,8-cineole and its esters, α-terpinyl and linalyl acetates [26]. Jyoti *et al.*, (2009) done a clinical trial on rat to study the seizure-suppressing effects of curcumin (chemical present in turmeric) on epileptogenesis and concluded that curcumin have antiepileptic potential [27]. The essential oil of clove is used as an anodyne (painkiller) for dental emergencies [28]. Cayenne (red pepper) may promote weight loss by raising core body and skin temperature, thus inducing greater energy expenditure. Dietary curcumin (0.002% and 0.01%) and turmeric (0.5%) were found to be effective against development of diabetic cataract in streptozotocin-induced diabetic rats [30]. Oil of cloves is used as an antiseptic during surgery, nutmeg for cough, and black pepper in small wounds to promote healing [31].

4. DOSAGE

The required dosages of different spices for human consumption are listed in Table 2. If the spices will be consumed more than required then they may cause various health hazards.

Table 3 Dosage of various spices for human consumption

Spice	Dosage
Turmeric	400-600 mg powder, one to three times a day[32]
Saffron	1.5 g/day[33]
Fenugreek	5 g/day [33]
Cinnamon	1 to 1.5 g/day[33]
Anise	0.5 to 3 g of seed, or 0.1 to 0.3 mL of the essential oil [33]
Nutmeg	1 to 2 mg/kg body weight[33]
Garlic	2 to 5 g of fresh raw garlic per day[33]
Ginger	0.25 to 1 g, 3 to 4 times daily[33]

5. DISADVANTAGE

On the other hand, spices have some demerits if it is being consumed more than the required dosage. Some spices may stimulate acid secretion and have deleterious effects on the gastric mucosal lining [34]. In injured stomach, cumin and coriander increase gastric secretion, and red pepper has an inhibitory effect [35]. Longer treatment with high turmeric dose has been associated with a significant decline in body weight gain and alterations in liver weight [36]. During processing of garlic, loss of active compounds or inhibition of enzymatic release may happen. Therefore, it is advisable to consume raw garlic [37].

6. CONCLUSION

Spices have been proven to be essential in human life in daily basis not only for flavor and taste; but also for medicinal properties as they contain various health promoting compounds. Therefore, consumption of appropriate dosage of spices is recommended as reported by different authors. Hence, the vast opportunities of spices can be recognized in food, pharmaceutical, cosmeceutical, nutraceutical and health care sectors for optimum uses of bioactive compounds of spices as functional ingredient.

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