Nutritional and medicinal aspects of coriander (Coriandrum sativum L.) A review

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Nutritional and medicinal aspects of coriander (*Coriandrum sativum* L.)

A review

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Abstract

Purpose – The purpose of this paper is to provide a comprehensive overview of multiple functions of the coriander plant, including its nutritional and nutraceutical benefits, with special reference to linalool.

Design/methodology/approach – The authors undertake a literature review of the coriander plant's history, chemical composition of coriander parts and its oil, and their nutraceutical potential. Various phytopharmacological appraisals have been discussed at length to investigate their important potential.

Findings – Coriander is an annual, herbaceous plant which originated from the Mediterranean and Middle Eastern regions and known as medicinal plants. Coriander contains an essential oil (0.03-2.6%). The different parts of this plant contain monoterpenes, limpnene, α-pinene, γ-terpinene, p-cymene, citronellol, borneol, camphor, coriandrin, geraniol, dihydrocoriandrin, coriandronsA-E, flavonoids and essential oils. It is used as a stomachic, spasmolytic and carminative which have a greater bioactive property. Various parts of this plant, such as seeds, leaves, flower and fruit, possess antioxidant activity, diuretic, anti-convulsant anti-diabetic activity, sedative hypnotic activity, anti-mutagenic, anti-microbial activity, anthelmintic activity. The physical properties, chemical composition and bioactivity affect the coriander's commercial value.

Research limitations/implications – Currently available information on coriander seeds and leaves is insufficient. These observations have led to continuing research aimed at identifying specific bioactive components in foods, such as antioxidants, which may be responsible for improving and maintaining health. Antioxidants are present in foods as vitamins, minerals, carotenoids, and polyphenols. Coriander is also rich in such compounds. Research supports that some of these foods, as part of an overall healthful diet, have the potential to delay the onset of many age-related diseases, so there is urgent need to explore the role of these compounds.

Originality/value – This review is unique in its comprehensive nature and reflects the importance of coriander as a medicinal food.

Keywords Food, Medicinal plants, Nutrition, Spices, Herbs, Coriander, Phenols, Volatile oil, Essential oil, Linalool, Antioxidants, Nutraceutical

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Introduction

Coriander (*Coriandrum sativum* L.) belongs to carrot ancestors (*Umbelliferae*) and genus *Coriandrum* embrace cultivated plant (*Coriandrum sativum*) and wild species (*Coriandrum tordylium*). Coriander has poles apart names in different languages, i.e. English (coriander), Urdu (Dhania), Arabic (Kuzbara), Hindi (Dhania), Chinese (Yuan sui), Greek (korion). The "coriander", is consequential from Greek word for "bed-bug", as smell of spanking new foliage is said to resemble that of bug plague-ridden bed line. It is mentioned in Sanskrit prose as far flipside as 5000 BC and in Greek Eber Papyrus as early as 1550 BC (Uhl, 2000). Coriander is referred to as "kusthumbari" or "dhanayaka" in the Sanscrit literature (Prakash, 1990).

Coriander was used in time-honored Greek medicines by Hippocrates (460-377 BC). The Egyptians called this herb as "spice of happiness", perhaps for the reason that it was well thought-out to be an aphrodisiac. It was used for cooking and for children's digestive sadden and diarrhea. The Romans and Greeks also used coriander to flavor wine and also as a medication. Afterward, it was introduced into Great Britain by the Romans (Livarda and van der Veen, 2008). The etymology of coriander begins with Greek word korannon, a combination of koris and annon (a fragrant anise) and referred to mature fruit (Uchibayashi, 2001). The Roman naturalist, first used the genus name Coriandrum, derived from koris (a stinking bug), in reference to fetid smell of the leaves and immature fruit (Blumenthal, 2000).

South Asia is the world's biggest producer of coriander and an impending exporter to the countries like the USA, Middle East, EU, and South East Asia. World production of coriander fruit is tricky to estimate, since official statistics infrequently restrain figures relating to this crop. A considerable magnitude of coriander is grown in dwelling gardens or on a diminutive scale, and is not recorded in any statistics. Captivating the different annotations on this subject matter into account, the worldwide production of coriander may be estimated at approximately 550,000 ha per annum (Diederichsen, 1996). The main producers of coriander fruits are the Russia, Ukraine, Morocco, Argentina, Mexico, India, and Romania. Other countries that produce at least some coriander by geographical region, are: the Near East (Iran, Israel, Lebanon, Kuwait, Syria and Turkey), the Middle East (Kasachstan, Bhutan, Pakistan, Kirgysia and Tadjikistan), the Far East (China, Burma and Thailand), the Americas (Chile, Argentina, Guatemala, Costa Rica, the USA, Paraguay and Canada), Africa (Algeria, Ethiopia, Egypt, Tunisia and Somalia), Europe (Bulgaria, England, Czechoslovakia, Hungary, France, Italy, Poland, The Netherlands and Yugoslavia). The tropical ambiance is hostile for ripening of the fruits and coriander is merely cultivated for the use of the fruits in mountainous areas of the tropics.

Importance

Because of health wellbeing and rehabilitated diet trends, leafy vegetables and salads are gaining much significance in the human diet. Since antediluvian times, herbs were the base for nearly all medicinal therapy until synthetic drugs were developed in the nineteenth century. Mediterranean diets have been connected with reduced occurrence of some chronic diseases, such as cancer and heart diseases (Keys, 1980). While dietary studies are multifaceted, Mediterranean diets do embrace considerable quantity of garlic, rosemary, basil and thyme. Herbs like coriander have been used for a large array of purposes including nutrition, medicine, beverages, flavorings, repellents, dyeing, cosmetics, fragrances, smoking, charms and industrial uses.

Today, herbs such as coriander are still found in 40 percent of prescription drugs. Culinary herbs have been grown and used for hundreds of years, and they are becoming increasingly popular for their knack to augment and complement the flavors of a wide diversity of foods (Hacskaylo, 1996). The US National Arboretum offers an substitute definition and describes spices as "flavorings that are dried and culinary herbs are fresh or dried leaves from plants which can be used for flavoring purposes in food" (Milner and Kaefer, 2007). Although hundreds of volatile compounds can be produced in aromatic plants, moderately few are typically liable for characteristic flavors or aromas and still fewer are generally used to delineate chemo types (Gil *et al.*, 2002).

Coriander, among other herbs, which might assist to elucidate some of the defensive effects observed in populations following more traditional Mediterranean diets. Given the long history of use of herbs such as coriander, they may be considered one of the earliest ever recorded functional foods. The herbs that have received the most scientific concentration in stare to influencing psychological processes have been pinched from the traditional medicines rather than the culinary herbs. A search of PsycINFO and MEDLINE using the various herb names (e.g. basil, coriander) and the terms cognition, attention, memory, dementia and anxiety found only one cram of the upshot of any of these herbs on psychological processes. It investigated the anxiolytic and hypnotic effects of lemon grass. In this placebo controlled, double-blind study, lemon grass was taken as herbal tea for two weeks; no effects were found (Leite *et al.*, 1986). The employ of herbal treatments for anxiety is perhaps the most common instance of herbal influence on mental health.

Coriander leaves are used as parsley like garnish with a fresh fragrance that is vital in, soups, and meat dishes because these are rich in vitamin A, B_2 (riboflavin), C and dietary fiber. Salads are incredibly beneficial for weight conscious persons due to their lofty vitamins and fiber contents. The dried seeds contribute to pleasantly aromatic spice that is much used in stews, cuisine, sweet breads, sausages and cakes (Peter, 2004).

Nutritional composition

The coriander fresh leaves contain 87.9 percent moisture, 3.3 percent protein, 6.5 percent carbohydrates, 1.7 percent total ash, 0.14 percent calcium, 0.06 percent phosphorus, 0.01 percent iron, 60 mg/100 g vitamin $B_{2.}$, 0.8 mg/100 g niacin, 135 mg/100 g vitamin C and 10,460 International unit (IU)/100 g vitamin A. 100 g of coriander seed contains nearly 11 g of starch, 20 g of fat, 11 g of protein, and nearly 30 g of crude fiber (Peter, 2004). The coriander seed contains 11.37 percent water, 11.49 percent crude protein, 19.15 percent fat, 28.43 percent crude fiber, 10.53 percent starch, 10.29 percent pentosans, 1.92 percent sugar, 4.98 percent mineral constituents, and 0.84 percent essential oil. The major compounds present in essential oil are linalool 67.7 percent, α-pinene 10.5 percent, γ-terpinene 9.0 percent, geranylacetate 4.0 percent, camphor 3.0 percent, and geraniol 1.9 percent. Coriander seed oil is included among 20 major essential oils in the world market. Its commercial value depends on its physical properties, chemical composition and aroma.

The aroma and flavor of coriander are attributable to essential oil present in oil glands in the mericarp (Diederichsen, 1996). In flavor compositions, coriander oil intermingles well with cardamom, bergamot, anise, nutmeg, clary, clove and sage. The oil can be extensively used as a flavoring agent in all types of foodstuff, including alcoholic beverages, candy, tobacco, pickles, seasonings and meat sauce. The average use level ranges from 0.1 to 100 ppm. Coriander oil also possesses antimicrobial

properties against selected pathogenic and saprophytic microorganisms, indicating that it may be useful as a disinfectant (Deans and Ritchie, 1987; Meena and Sethi, 1994; Elgayyar *et al.*, 2001).

The composition of coriander (*Coriandrum sativum* L.) has been mentioned in a variety of studies. The results of HPLC investigations showed the presence of apigenin, luteolin, hesperidin, hyperoside, diosmin, vicenin, dihydroquercetin, orientine, catechin, chrysoeriol, ferulic acid, salicylic acid, gallic acid, dicoumarin, 4-hydroxycoumarin, esculetin, esculin, tartaric acid, maleic acid and arbutin. The elemental and amino acid analyses of coriander showed that the customary elements are sodium, potassium, calcium and phosphorus, while the prevailing amino acids are asparagine, glutamine and arginine (Oganesyan *et al.*, 2007).

Misharina (2001) found the coriander seed in Russia has more concentration of camphor (69.75 percent) and less concentration of linalool (2.96 percent), while seed from New Zealand have camphor (5.1 percent) and linalool (65.8 percent) (Smallfield *et al.*, 2001). The composition of coriander fruits and fresh cilantro was affected by degree of maturity and γ-irradiation, respectively (Fan and Sokorai, 2002; Msaada *et al.*, 2007).

Medicinal importance of coriander

Coriander has been used in medicines for thousands of years (Mathias, 1994). Various parts of this plant such as leaves, flower seed, and fruit, possess antioxidant activity, diuretic, ant-diabetic, sedative, anti-microbial activity, anti-convulsant activity, hypnotic activity and anthelmintic activity and anti-mutagenic (Pathak *et al.*, 2011; Rajeshwari and Andallu, 2011).

The fruits and oil of coriander are used to wrap the taste or correct the nauseating or griping qualities of other medicines. Coriander is also used in aromatherapy (Cooksley, 2003). In folk medicine, coriander finds use in opposition to intestinal parasites, anti-inflammatory and as a part of embrocations for joint pain and rheumatism (Wichtl, 1994). For pharmaceutical preparations oil is principally used as a flavoring agent (Leung and Foster, 1996). Coriander can also be used as value added form like other seed spices as volatile oil, curry powder, oleoresin, consumer packed spices, ground spices and organic spices. Essential oil of coriander is used in the flavoring of a number of food products. It is principally used as a flavoring agent in the cocoa, liquor and chocolate industries this may be owing to the nature of chemical composition of coriander essential oil. Like the fruits, it is also employed in medicine as a flavoring or as a carminative agent. It has the advantage of being more stable and of retaining its agreeable odor longer than any other oil of its class (Purseglove *et al.*, 1981).

Because coriander oil also has bactericidal and fungicidal properties, it is used as a carminative, stomachic and spasmolytic. It is also used for diarrhea, sub-acid gastritis and dyspepsia of diverse genesis as well as for its stomachic, digestive stimulation and antibilious properties (Platel and Srinivasan, 2004). Coriander has been reported to own strong lipolytic activity (Leung and Foster, 1996), and, as an affiliate of carrot family, its use has been suggested with caution, because of potential allergic reactions from furanocoumarins (Brinker, 1998). Commercial essential oils from 28 plant species has been tested for their nematicidal activities against the pine wood nematode, *Bursaphelenchus xylophilus*. Good nematicidal activity against *Bursaphelenchus xylophilus* was achieved with essential oils of coriander (*Coriandrum sativum*), valerian (*Valeriana wallichii*) and oriental sweetgum (*Liquidambar orientalis*). Analysis by gas chromatography-mass

spectrometry led to the identification of 26, 11, and four major compounds from coriander (*Coriandrum sativum*), oriental sweetgum (*Liquidambar orientalis*), and valerian (*Valeriana wallichii*) oils, correspondingly. Among the compounds, *trans*-cinnamyl alcohol, benzaldehyde, *cis*-asarone, nonanal, octanal, decanal, *trans*-2 decenal, dodecanal, undecanal, decanol and *trans*-2-decen-1-ol showed burly nematicidal activity (Kim *et al.*, 2008; Rajeshwari and Andallu, 2011).

Antioxidant activity of coriander

Antioxidants refer to any substances in attendance at stumpy concentration in foodstuffs and capable to significantly avert oxidation by playing a responsibility in antioxidation as a free radical scavenger, chelator, reducing agent, and/or singlet oxygen scavenger (Cozzi *et al.*, 1997). Only a few species are allowed as food additives by the law because of their toxicity effects and other side effects afar registered synthetic antioxidants. Butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT), tertiary butylatedhydroquinone (TBHQ) and pueraria glycoside (PG) are typical antioxidants permitted as the food additives. There is a need for food scientists to fervor of seeking natural antioxidants from the various sources because harms of human health caused by food additives (Dorman *et al.*, 2008).

It is emphasized that use of spices and herbs as antioxidants is a promising alternative to the use of synthetic antioxidants. Chemical constituents having antioxidant activity are found in high concentration in plants. The benefits resulting from the use of natural products rich in bioactive substances has promoted the growing interest of food industries (El-Ghorab *et al.*, 2008). Herbs and spices are one of the important sources for search of natural antioxidants from safety point of view. Coriander leaves showed stronger antioxidant activity than the seeds, and in both parts of coriander. However, the effects are more potent in extracts from leaves than in seeds from coriander and it seems that compounds of medium polarity are most potent, even if their total antioxidant contribution in the plant is small (Dorman *et al.*, 2008; Cozzi *et al.*, 1997). There is a positive correlation between total phenolic content and antioxidant effect; thus a screening of phenolic content in coriander extracts will probably indicate the presence of compounds with antioxidant activity (Wangensteen *et al.*, 2004; El-Ghorab *et al.*, 2006). The essential oils from a number of herbs and spices were also studied for antioxidant activity, e.g. oregano, rosemary, sage, clove, coriander (Baratta *et al.*, 1998), cumin, fennel, thyme, marjoram, laurel, caraway, peppermint, basil, cinnamon, nutmeg, dill, black pepper (Lagouri and Boskou, 1995). Although compounds in essential oils such as carvone from caraway, linalool from coriander, eugenol from clove, thymol from thyme and thujone from sage possess antioxidant activity, the aromatic character of these compounds limits the use of essential oils as antioxidants in foods (Madsen and Bertelsen, 1995). In carotenoids fractions obtained from coriander etheric extract, β-carotene has been identified as the principal antioxidant component. No significant difference in antioxidant activity was found when compared to the other carotenoids (Guerra *et al.*, 2005).

Antioxidant activity of all volatile and non volatile extracts of coriander seeds and leaves can be measured by using different methods, i.e. DPPH free radical scavenging activity assay and ferric reducing antioxidant power (FRAP) (El-Ghorab *et al.*, 2007; Shehwar *et al.*, 2012).

Coriander seed essential oil was shown to have greater antioxidant activity against radical generating activity of 1, 1-diphenyl-2-picrylhydrazyl in several oils. The order

of effectiveness among various oil in inhibiting free radicals was coriander > black cumin > cottonseed > peanut > linseed > olive (Ramadan and Moersel, 2006). Wangensteen *et al.* (2004), found that scavenging activity of coriander seed essential oil is higher than coriander leaves essential oil. The antioxidant activity of coriander seed essential oil was might be due to presence of linalool in high concentration as compared to leaf essential oil. There have been many reports on the antioxidant activities of essential oils from various plants, including capers (El-Ghorab *et al.*, 2007), carnation (El-Ghorab *et al.*, 2006), clove and other spices (Shan *et al.*, 2005; El-Ghorab *et al.*, 2010). It is difficult to pinpoint the compounds giving antioxidant activities to the samples because these oils contained numerous compounds. However, some compounds such as linalool, α-pinene, limonene, and camphene had been reported to possess strong antioxidant activity (Shibamoto and Wei, 2007).

From aqueous extract of coriander, fractions were identified using chromatography in a silica gel column. Their antioxidant activity, according to the β-carotene/linoleic acid model, was similar to one another but inferior to that of the crude extract and of butylated hydroxytoluene. It was noted that caffeic acid (4.34 mg/ml), protocatechinic acid (6.43 mg/ml) and glycitin (3.27 mg/ml) were present in high concentration. These are principal components responsible for the antioxidant activity of the aqueous coriander extract (Melo *et al.*, 2005).

Coriander oil as a source for linalool

The different parts of this plant contain linalool, α-pinene, monoterpenes, limpnene, γ-terpinene, borneol, p-cymene, camphor, citronellol, geraniol, coriandrin, coriandronsA-E, dihydrocoriandrin, flavonoids and essential oils (Pathak *et al.*, 2011). Linalool is the main volatile compound in coriander seeds; typically constituting more than 50 percent of total essential oil (Gil *et al.*, 2002) which has been investigated for its safety. The seeds contain on average 18 percent oil (fatty acids/triglycerides); however, the essential oil content of seeds is approximately 0.84 percent. Beyond essential oil, coriander also contains fatty acid oil which contains oleic, petroselinic and linolenic fatty acids. It forms approximately two-thirds of the oil (Gil *et al.*, 2002; Grosso *et al.*, 2008).

Typical compositional analysis of coriander oil is as follows: alcohols: linalool (60-80 percent), geraniol (1.2-4.6 percent), terpinen-4-ol (trace-3 percent), α-terpineol (< 0.5 percent); hydrocarbons: γ-terpinene (1-8 percent), ρ-cymene (trace-3.5 percent), limonene (0.5-4 percent), α-pinene (0.2-8.5 percent), camphene (trace-1.4 percent), myrcene (0.2-2 percent); ketones (7-9 percent): camphor (0.9-4.9 percent); esters: geranyl acetate (0.1-4.7 percent), linalyl acetate (0-2.7 percent). After detailed analysis of coriander herb essential oil presence of major components such as (*E*)-2-decenal, dodecenal, (*E*)-2-tridecenal, dodecanal were assessed by Potter and Fagerson (1990). However, linalool was also present in oil, since no effort was made to separate fruits, which contain internal oil canals rich in linalool (Purseglove *et al.*, 1981).

Composition of coriander seed essential oil is different at different places in world which is mainly affected by length and condition of storage (Misharina, 2001). Yield of essential oil content of dried fruits varies from 0.03 to 2.6 percent, depending on the species, growing region and climatic conditions (Diederichsen, 1996; Peter, 2004). Species cultivated in New Zealand have linalool, α-pinene, γ-terpinene, camphor and limonene were 65.8, 6.8, 6.1, 5.1, 2.7 percent, respectively (Smallfield *et al.*, 2001; Smallfield *et al.*, 2001; Gil *et al.*, 2002). Misharina (2001) found that linalool is (68 percent) in Russian

coriander seed essential oil. There is a strong dependence among temperature, radiance during fruit development, and water supply of crops of coriander and its essential oil content (Hornok, 1986; Carrubba *et al.*, 2006).

In coriander seed 122 constituents are present (BACIS, 1999), although the final number may be >200. Approximately, 97 percent of the total oil is constituted by 18 main components. When reconstituted in the concentrations found in the natural sample, the reconstituted oil did not give the odor impression of coriander oil (Smallfield, 2003). Hence, a major sensory effect of the oil apparently comes from the remaining trace constituents that occur, on average, in concentrations of about 0.01 percent or less. The characteristic aroma of oil is due to mono and polyunsaturated fatty acids (Bauer *et al.*, 1997). Water soluble portion of the methanol extract of coriander fruit has 33 compounds (Ishikawa *et al.*, 2003). Two photosensitizing furanocoumarins have been isolated and characterized from coriander (Ashwood-Smith *et al.*, 1989). Geographic location, fertilization and weediness (weed competition) also affected the chemical profile (Gil *et al.*, 2002).

Spice-based compound, linalool reduces the effects of trauma on the immune system. Linalool is a fragrant compound found in numerous plants including the spices, sweet basil, cinnamon, thyme, bay leaf and fruits such as mangoes and citrus. For several years it has been used extensively in aromatherapy essential oils and as a fragrance for shampoos, soaps, and other toiletries (Keith, 2010). Linalool is well acknowledged as one of the most imperative calming fragrances and was previously thought to operate only on the nervous system.

In vivo studies related to coriander

Al-Jaff (2011) conducted a cram to inspect the potential upshot of coriander seeds on physiological traits. 180 day-old Arbor Acer broiler chick were arbitrarily assigned to four dietary treatments. Birds were fed experimental diets containing 0 percent (T_1), 1 percent (T_2), 2 percent (T_3) and 3 percent (T_4) coriander seed. Feed and water were provided *ad libitum* during the experiment. Performance and physiological parameters were monitored at the conclusion of the study (six weeks of age) which includes live body weight, feed conversion ratio, total protein, albumin, globulin, A/G ratio, GOT, GTP, Alkaline phosphatase, cholesterol, glucose, high density lipoprotein (HDL), low density lipoprotein (LDL), Triglycerides, uric acid, phospholipids, creatinine and antibody titer (ND). Final body weight was found higher T_3 than all other groups and feed conversion ratio was significantly better for birds in T_3 and T_4 than all other groups. Serum protein and albumin were T_3, while serum globulin was lower in T_3 when compared with other groups. GOT and GPT were lower for T_3 and T_4, while alkaline phosphatase was lower in T_3 group. Serum glucose lower in T_3 than all other group, Serum cholesterol was lower in T_3 and T_4 compared with other groups. LDL was lower in T_3 group, while HDL was lower in T_3 and T_4 groups when compared with the control. Serum triglycerides and antibody titers were higher in T_3 and T_4 coriander seed when compared with other groups. It was concluded from this study that the inclusion of coriander seeds at levels of 2 percent have a positive effect on broiler performance, blood pictures and immune system during heat stress.

The effects of coriander oil on pentobarbital induced sleeping time in mice were investigated by Marcus and Lichtenstein (1982). Groups of six "Sprague Dawley male white mice" (although, no such strain has been reported) were injected intraperitoneally with 50 mg/kg pentobarbital plus 50 mg/kg of coriander oil. Simultaneous administration of coriander oil and pentobarbital to mice did not significantly

increase pentobarbital – induced sleeping time. However, administration of coriander oil 30 min prior to the administration of pentobarbital resulted in a prolongation of pentobarbital-induced sleeping time (146 percent of control) (Marcus and Lichtenstein, 1982). Coriander has been advocated as an anti-diabetic remedy. Recent experimental studies have suggested antihyperglycemic effects of coriander seeds in streptozotocin-diabetic mice (Swanston-Flatt *et al.*, 1990; Gray and Flatt, 1999). Gray and Flatt (1999) reported that incorporation of coriander into the diet (62.5 g/kg) or in drinking water (2.5 g/l, prepared by 15 min decoction) reduced hyperglycemia of streptozotocin-diabetic mice. Medhin *et al.* (1986a) demonstrated that aqueous extracts of coriander seeds inhibit the electrically-evoked contractions of spiral strips and tubular segments of isolated central ear artery from rabbit. In another study, Medhin *et al.* (1986b) reported that the water extract of coriander seed had hypotensive effects in rats.

Changes in lipid metabolism was observed in Sprague Dawley female rats when fed on a high fat diet containing coriander seed powder (10 percent) for period of 75 days (Chithra and Leelamma, 1997). The levels of total cholesterol and triglycerides were decreased significantly in serum, liver and heart. The serum levels of very low and LDL cholesterol were decreased, while HDL cholesterol significantly increased. The investigators concluded that coriander seeds had hypolipidemic effects. In another study (Chithra and Leelamma, 1999) the changes in levels of lipid peroxides and activity of antioxidant enzymes in Sprague Dawley female rats maintained on a high fat diet containing 10 percent coriander seed powder for 90 days. Feeding a diet containing coriander seed powder resulted in a significant decrease in the levels of lipid peroxides as determined by malondialdehyde, hydroperoxides and conjugated dienes in liver and heart. The levels of free fatty acids in serum, liver and heart of the treated animals were significantly decreased. Antioxidant related enzymes, such as superoxide dismutase, catalase, glutathione peroxidase, glutathione S-transferase, glucose six phosphate dehydrogenase and glutathione reductase were significantly increased in the liver and heart of the treated animals. It was concluded that coriander seed may protect various tissues by preventing the formation of free radicals. Feeding coriander seed (10 percent) protected against the 1, 2-dimethylhydrazine induced colon and intestine tumors in male Sprague Dawley rats (Chithra and Leelamma, 2000). As a major constituent of a spice mix added to a diet (2 percent), "coriander", at a level of 40 percent in mix (80 ppm), when fed to female Wistar rats for eight weeks, "favorably enhanced" the activities of pancreatic lipase, chymotrypsin and amylase. Additionally, feeding the diet containing the spice mix significantly stimulated the bile flow and bile acid secretion (Platel *et al.*, 2002).

Scientists also demonstrated that linalool action extends ahead of the brain to the immune system itself. In a controlled study the researchers exposed a treatment group of stressed rats to linalool fragrance. At the end of the 2 hour stress period they measured the hormone levels, white blood cell count and gene activation levels of both the control and treated groups. The blood tests following the experiment showed that stress hormone levels in both the control and treatment groups were appreciably raised at the end of the 2 hour stress period. Under ordinary circumstances corticoid stress hormones would be expected to suppress the immune response. However, while the rats that were not exposed to linalool showed the expected stress-related drop in their white blood cell counts, those that were exposed to linalool fragrance maintained customary leukocyte and lymphocyte white blood cell levels. Moreover, the rats in the linalool group had far smaller number "stress genes" activated than those in the control group. This study

indicates that inhaling an aromatic compound such as linalool has both physiological effect and a psychological; and reflects our increasing indulgent of the all-embracing links and interactions between the nervous and immune systems. For some time now peoples are well conscious that spices contain many important antioxidants and other bioactive compounds that have an exceptionally positive impact on our health. Now they know that when they bite into that Caprese salad the delicious basil fragrance is not only going to enhance their dining experience, but will also help to protect them from the latest viruses doing the rounds. These tasty spices will start defending immune system even before they reach stomach (Nakamura *et al.*, 2009).

Conclusion

Inclusion of both seeds and leaves from coriander in the cuisine will increase the content of antioxidants, and thus probably prevent oxidative deterioration of food. However, it is uncertain if quantity of spices in diet is enough to have an influence on antioxidant defense of the body. So coriander seeds and leaves may be used as a potential source of food flavoring and antioxidants. Value addition can be as simple as presenting a commodity in a cleaned graded form, which would instill confidence in the consumers for its quality image. On the other hand, it can be a completely different product such as oil, oleoresins, etc. The value added form of spices has tremendous growth potential. The global market is increasingly shifting away from the commodity form towards the value added form of consumer packed branded spices, which overcome the disadvantages of raw spices. The future is bright, but significant investment in evaluation and feeding trials to demonstrate the health promoting properties is required. Numerous phytochemical and pharmacological studies have been conducted on different parts of *Coriander sativum*. The article supports the potential of *Coriander sativum* as a nutritional and medicinal plant. More research can be done to explore the unexplored and idle potential of this plant. Considering these potentials, coriander functional ingredients possess a tremendous prospect in the health associated industries. Research related to human interventions will open new array of utilization of coriander as a functional food.

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