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The potential use of some spices as immunity booster

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Abstract

Spices are normally used for flavor to make food aromatic, hot, savory and sweet. Spices not only add aroma to the food but also give a lot of health benefits and nutritional values. Some of the spices used in Egypt are cinnamon, cumin, turmeric, black cumin etc. Many people do not know the importance of spices and its effect on the immune system. The main aim is to high light the role of commonly used spices on immunity. In this review we list some bakery products that use some spices and can be used to improve the immunity of humans.

Keywords: Immunity; Cinnamon; Turmeric; Cumin; Black cumin

1. Introduction

Immunity plays a crucial role in defending against various emerging and seasonal outbreaks of infections like cold. Boosting our natural immunity is that the best root to stay healthy. Many herbs and spices have immune-modulating properties. Spices play many roles e.g.: providing aroma and flavor to the food but most significantly they have a role in digestion. They're also used in treatment of various diseases like cardiovascular, neurodegenerative diseases. It helps in improving the immunity and also gastrointestinal health [1]. Some herbs and spices have significant oxidative effects [2]. Spices are also, used to provide different antimicrobial property [3].

In January 2020, the planet faced an epidemic of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV- 2). Evidence of high human-to-human transmissibility of SARS-CoV-2 has made social isolation the simplest precaution to avoid the spread of COVID-19 [4]. This pandemic is substantially affecting lifestyles, healthcare systems, and national and global economies all over the world. Social isolation is usually an unpleasant experience which will have negative effects on psychological state [5]**.** It has been suggested that, until quarantine ends, self-isolation is probably going to cause psychological and emotional symptoms [6], changes in mood and altered sleep or eating patterns [7], worsening of chronic health conditions, weight gain, and increased use of alcohol, tobacco, or illegal drugs [8].

Some studies have shown the importance of early nutritional supplementation for non-critical patients hospitalized with COVID-19, emphasizing the importance of a balanced diet, and the necessity of unprocessed and healthy food choices [9; 10]. The interaction between nutrition and infections is well accepted and valued by generations of health-care professionals. Before the use of antibiotics, diet was an integral and essential part of infection management. This strategy needs to be rescued, because understanding of the immune response and nutrition has considerably expanded [11].

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The global pattern of food consumption has been associated with increased inflammation and uncontrolled infectious processes related to lower immune system responsiveness [12; 13]. Additionally, the impact of the consumption of ultra-processed foods has been related to imbalances in the human intestinal microbiota.

2. Role and Effects of Micronutrients Supplementation

Supplementation with micronutrients generally reverses many impaired immune responses. During this study, close associations between the regulation of immune processes and a few trace elements also, some common spices are pointed out.

2.1. Role of Some Minerals in Immunity

Dietary zinc and selenium are important nutritional elements for the immune reaction to guard against the development of diseases. These two physiologically essential trace elements interact in many biochemical processes. One among the inorganic selenium species, selenates couple with the reduced-to-oxidized glutathione and metallothionein-to-thionein redox pairs to release or bind zinc metal [14,15].

2.2. Zinc and Immunity

In this COVID-19 situation, zinc is considered as a supportive treatment therapy as it has direct antiviral effects [16]. It is found that zinc supplementation may have positive effects in the treatment of COVID-19 patient [17]. Some meta-analysis found that zinc decreased the prevalence and incidences of pneumonia as well as duration of common cold [**18**]. Zinc deficiency can cause loss of T helper cells and also responsible for atrophy of thymus and spleen. The common sources of zinc are meat, cheese, cereals and grains, shellfish etc.

2.3. Selenium and Immunity

Selenium has important effect on both innate and acquired immunity. Selenium enhances the function of T lymphocyte and B lymphocyte and also increases the activity of natural killer cell [19, 20]. A study found that selenium supplementation improved immune function in the human body [21]. The common sources of selenium are fish, meat, egg and nuts. Supplementation of selenium also has some adverse effects on the body.

3. Role of Some Vitamins in Immunity

3.1. Vitamin E and Immunity

Vitamin E acts as a scavenger of free radical by blocking the per-oxidation of polyunsaturated fatty acids (PUFA) and also acts as antioxidants. It is suggested that vitamin E is an important nutrient in the immune system [22]. It is found that there is a positive association between vitamin E and cell-mediated immune responses and vitamin E supplementation appears to be beneficial for adults [23]. Several studies identified that vitamin E supplementation reduced the risk of respiratory tract infections and decreased the duration of respiratory tract infections among adults [24]. The common sources of vitamin E are Plant oils (soya, corn, olive), nuts, seeds, wheat germ and the recommendation of vitamin E for adult people is 15-20 mg [25].

3.2. Vitamin A and Immunity

The roles of vitamin A in the immunity system and host susceptibility to infection are identified in many studies [26,27]. The main functions of vitamin A are helping in visions, providing immunity, contributing in gene expression, etc. Vitamin A is required for immune cell maturation and functioning as boosting the immune system is the main focus to prevent the spread of COVID-19. Deficiency of vitamin A may impair barrier functions and immune response. Vitamin A also supports in phagocytic activity to promote bacteria killing. Vitamin A helps to increase the activity of natural killer cells which have antiviral defenses [28, 29, 30]. Common sources of vitamin A are Liver, eggs, oily fish, fortified margarine, dairy products, carrots, orange fruits, green and yellow vegetables and tomato juice and the recommendation of vitamin A intake for adults is 3000-5000 IU [25].

3.3. Vitamin B-Complex and Immunity

B vitamins are mainly involved in intestinal immune regulation and help in the gut-barrier functions. Folic acid increases the number of circulating T lymphocyte, but the activity of neutrophils appears unchanged. Folic acid, vitamin B6 and B12 enhanced the activity of natural killer cells which would be important in antiviral defense [31,32]. The common sources of vitamin B complex are Poultry, fish, meat, nuts, legumes, whole grains, potatoes, meat, egg, seaweed etc. and the recommendation of vitamin B6 and B12 for adults are 1.3-2 mg and 2.4-6 μg respectively [25].

4. Some common spices

4.1. Cinnamon

Cinnamon (*Cinnamomum zeyeanicum*) belongs to genus *Cinnamomum*, family *Lauraceae* which is distributed in India, Egypt, China, Srilanka and Australia. Cinnamon leaves and bark are used extensively as spices in food or to produce essential oils [33]. Cinnamon has a long track record as a non-toxic natural product and it is easily manufactured at low cost [34]. In fact, cinnamon fits well as a possible natural food additive and medicine because it is recognized "Generally Recognized as Safe" (GRAS) by the FDA [35].

The proximate analysis of cinnamon revealed that it contained ash (2.01%), crude protein (3.05%), crude fat (4.0%) and crude fiber (17.14). Aromatic plants, in particular cinnamon, provide protein, fibre, volatile components, vitamins (A, C and B), minerals (Ca, P, Na, K and Fe) and chemical compounds that are known to have disease preventing and promoting health properties [36].

As part of the mineral's composition, Zn concentration reached 2.01mg/100gm, cinnamon may also present a low concentration of iodine (6 mg/100 g), selenium (3-15 mg/100 g), chromium (14 mg/100 g) and molybdenum (3 mg/100 g). While for vitamins, vitamin A was (9.33 RE); vitamin B1 (337mg/100gm); vitamin E (27 mg/100gm) and vitamin C (3.80 mg/100gm). Meanwhile ascorbic acid was 1.332 mg/100gm [37, 38].

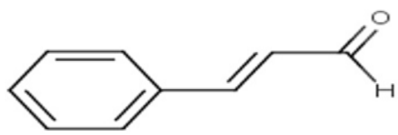


Figure 1 Structure of Cinnamaldehyde: the Basic Active Substance of Cinnamon

Cinnamaldehyde (or cinnamic aldehyde) is one of the primary chemical constituents of the spice crop and it is responsible by the sweet taste of cinnamon [39]. Cinnamaldehyde has demonstrates anti-inflammatory, antitumor, cholesterol- and lipid-lowering, antiviral properties and antimicrobial effect [40].

Cinnamaldehyde was the compound of cinnamon extract which had the greatest anti-neuroinflammatory capacity. However, the possibility of synergistic or additive effect can exist among constituents, such as 2-methoxy cinnamaldehyde and cinnamaldehyde [41]. It was also attributed to sodium benzoate, a metabolite of cinnamon, action in neuro-inflammatory disorder [42].

5. Health Benefits

Studies have shown therapeutic effects of cinnamon including its antimicrobial, antiviral, antifungal, antioxidant, antitumor, antihypertensive, antilipemic, antidiabetic, gastroprotective, and immunomodulatory effects. Regular use of cinnamon prevents throat infections [43].

Cinnamon (*Cinnamomum zeyeanicum*) is one of the spices that have the highest antibacterial activity. Cinnamon extracts exhibited strong anti-inflammatory properties, related with their polyphenols [44, 45]. Cinnamon extract (300 mg/day) decreased insulin resistance in fructose-fed diabetic rats [46]. If there is an imbalance of T cells in the body cinnamon can effectively increase its number. Cinnamon oil possesses antimicrobial action, Muthuswamy *et al.* [47] reported that the range 10-150 μg ml can inhibit the action of different kinds of bacteria on food products. Besides, it is a potent antimicrobial and antioxidant [48, 49].

The positive health effects associated with cinnamon have been reported in several studies [50, 39]. In particular, the most well-documented health benefit provided by this spice is related with the prevention and treatment of several different chronic diseases such as diabetes, Alzheimer and Parkinson's disease [51, 52]. However, cinnamon has also been used for controlling blood glucose levels in diabetes, as an antineoplastic, as a repellent and as an anti-inflammatory [53-55].

5.1. Black Cumin

Black cumin (*Nigella sativa*) is one of the most revered medicinal seeds in history. The best seeds come from Egypt where they grow under almost perfect conditions. Black cumin has many nutritional and pharmaceutical uses. The seed can be added to tea, coffee, casseroles or breads, used in canning, or extracted in wine or vinegar. The ground seed could be mixed with honey or sprinkled on salads.

Consequently, black cumin has been extensively studied particularly, which justifies its broad traditional therapeutic value. The reason might be found in the complex chemical composition of the seeds. Black cumin seed has over 100 different chemical constituents, including abundant sources of all the essential fatty acids [56].

The seeds contain a yellowish volatile oil (0.5–1.6%), a fixed oil (35.6–41.6%), proteins (22.7%), amino acids (e.g. lysine, leucine, isoleucine, valine, glycine, alanine, phenylalanine, cystine, glutamic acid, aspartic acid, proline, serine, threonine, tryptophan and tyrosine), reducing sugars, mucilage, alkaloids, organic acids, tannins, resins, toxic glucoside, metarbin, bitter principles, glycosidal saponins, melanthin resembling helleborin, melanthigenin, ash, moisture and ascorbic acid [57,58]. The seeds have also been found to contain crude fibre, minerals (e.g. Fe 9.70 mg/100 gm, Zn 6.23 mg/100 gm and Ca 543.0 mg/100 gm) [59]. While Amin, and Hosseinzadeh [60] reported vitamins like vitamin A, thiamine, niacin, pyridoxine, folic acid and vitamin C ranged from 1-4%. Also, findings showed that black cumin fixed and essential oils are rich source of phytochemicals and can be utilized against lifestyle disorders like hyperglycemia and hypercholesterolemia [61].

Black cumin seed is composed of fixed (stable) and essential (volatile) oil responsible for many beneficial effects. Fixed oil contains appreciable quantities of unsaturated fatty acids (linoleic, oleic, and linolenic acids) as well as saturated fatty acids in minor amounts (arachidonic and eicosenoic acids) [62, 63]. Moreover, essential oil extracted from black cumin is of functional importance because of its rich volatiles, such as thymoquinone (TQ) 18.4–24%, monoterpenes 46% and essential (volatile) oil [64; 65].

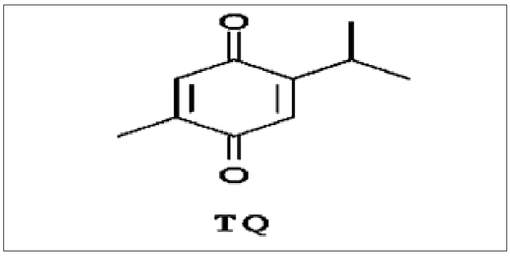


Figure 2 Structure of Thymoquinone: the Basic Active Substance of Nigella sativa

Besides the fatty acid profile, it also consists of considerable quantities of vitamin E (tocopherol α, β, and γ), retinol (vitamin A), carotenoids (β-carotene), and thymoquinone (2-isopropyl-5-methyl-1,4-benzoquinone). Fat-soluble vitamins comprise more than 0.2% of the total oil content. Alkaloids such as nigellimine, nigellidine, and nigellicine are also present in trace amounts [66, 67]. Also, black cumin has been known to contain considerable quantities of phytosterols including β-sitosterol, avenasterol, stigmasterol, campesterol, and lanosterol [61, 68].

6. Health Benefits

Traditional uses of this amazing herb originate from the ancient Egyptians, Greeks, and Romans. N. sativa and its main active constituent TQ are attributed to numerous pharmacological activities. Up to now, cytotoxic, antioxidant, immune enhancement, gastroprotective, hepatoprotective, antitussive, hypolipidemic, and cardioprotective effects, hypoglycemic, hypotensive, and antimicrobial effects are demonstrated. Additionally, beneficial effects of N. Sativa and thymoquinone on convulsions, depression, men's infertility, memory improvement, nociception, and inflammation are discussed [69-71]. Also, it has beneficial effects against diseases such as cancer, diabetes and cardiovascular disease have been highlighted [72, 73, 65].

Al-Ghamdi [74] demonstrated that the aqueous extract of N. sativa possesses an anti-inflammatory effect. Also, the methanolic extracts of different germination phases of N. sativa showed significant anti-inflammatory effects [75]. The thymoquinone (TQ) extracted from the black cumin seeds are shown to have a significant antioxidant role and improves body's defense system [76, 77].

6.1. Turmeric

Turmeric (*Curcuma longa*), a medicinal plant native of tropical South Asia. It belongs to the ginger family, Zingiberaceae. It is commonly used as a spice, food preservative and colouring agent [78]. It exhibits antioxidant [79] anti-inflammatory, antimicrobial and anti-carcinogenic properties and is known to play a role in preventing diseases like cancer and cardiovascular diseases [80]. The active components in turmeric, such as curcumin, which is a yellow coloring agent, present in the rhizomes of turmeric, and tetrahydro-curcumin (THC), which is the major colorless metabolites of curcumin, also possess antidiabetic, anti-inflammatory, and antioxidant activity. In the scientific literature, a large amount of information is available regarding the nutritional properties of turmeric and its use to develop sweet bakery products [81- 84].

Turmeric powder contains 3.60gm protein and 5.14gm fat. Also, it is rich in minerals (19 mg/100gm iron; 3 mg/100gm zinc). Also, vitamins are high. Riboflavin is 0.23, niacin 5.14 mg/100gm and folic acid 39 microgram/100 gm. These results agree with work by El-Bedawy *et al* [85] and Mohamed *et al.* [86].

Curcumin, a polyphenol, possesses antioxidant, anti-inflammatory, antiviral, and antifungal properties of curcuminoids. It is the main and active component present in turmeric, containing 2 to 8% of the spice and found to have antioxidant [87] and antiseptic activities [88].

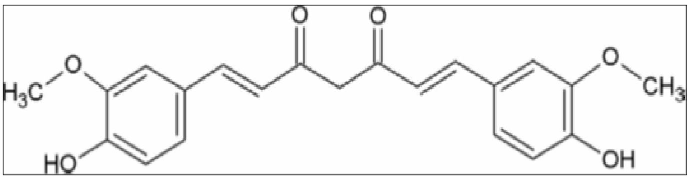


Figure 3 Structure of Curcumin: the Basic Active Substance of *Curcuma longa*

Human trials using up to 800 to 2500 mg of curcumin per day for 3 months found no toxicity from curcumin. It is a potent antiviral and can reduce replication of viruses. Curcumin has been shown to have reno-protective and cardioprotective properties. However, it has poor bioavailability, which is primarily due to its poor absorption and metabolic instability. One teaspoon full of turmeric powder mixed in hot milk two to three times a day boosts immunity in viral infection.

7. Health Benefits

Relief from Arthritic: Pain Turmeric's anti-inflammatory properties treat osteoarthritis and rheumatoid arthritis. The antioxidant also destroys the free radicals in the body that damage the cells [89, 79].

Good for the Brain: Research has found that curcumin promotes repair in the stem cells of the brain - the same stem cells that can help in the recovery from neurodegenerative diseases like stroke and Alzheimer's [90].

Aids in Digestion: The major components of the spice stimulate the gallbladder to produce bile, instantly making the digestive system more efficient. It is also known to reduce symptoms of bloating and gas [90, 91].

Healing properties: Its natural antiseptic and anti- bacterial properties make it an effective disinfectant. The powder can be sprinkled on the affected area to help it heal faster [92].

Turmeric & Diabetes: The anti-inflammatory and antioxidant properties of curcumin have been found to delay the onset of Type 2 Diabetes in people with pre-diabetes. It further helps moderate insulin levels and boosts the effect of medications that treat diabetes [78].

Boost Immunity: Lipopolysaccharide - a substance in turmeric with anti-bacterial, anti- viral and anti-fungal agents helps stimulate the human immune system [90, 93].

Helpful in preventing heart disease: Consumption of turmeric regularly is effective in keeping the heart healthy. This happens due to the anti-oxidant properties present in this herb. According to Sahoo *et al.* [94], this ayurvedic medicine has also been proved to reduce obesity and bad cholesterol from the body and thus improving overall heart health.

7.1. Cumin

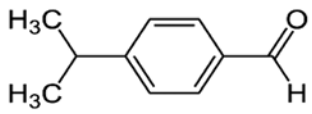
Cumin (*Cuminum cyminum*) Cumin oil also called di -Homo - linoleic acid is used as a powerful antioxidant agent [70]. The use of cumin plants can extend to the treatment of asthma, diabetes inflammation, and hypertension etc. [60]. The composition of cumin is oil, proteins, carbohydrates, vitamins, minerals etc. Cumin's distinctive flavor is because of its crucial oil content. Cuminaldehyde, cymene, cuminic alcohol, and terpenoids are the principal volatile components of cumin [95].

Cumin seeds are nutritionally rich; they provide high amounts of fat (especially monounsaturated fat), protein, and dietary fibre. Vitamins B and E and several dietary minerals, especially iron, are also considerable in cumin seeds. Cuminaldehyde (Figure 4), cymene, and terpenoids are the major volatile components of cumin [96].

The seeds are used in cooking and the volatile oil is used for food flavoring and in cosmetics and perfumery industries. Cumin also has a number of medicinal uses and helps in curing many diseases.

Cumin seed contains moisture (7%), volatile oil (3–4%), protein (12%), total ash (10%), fiber (11%), carbohydrate (33%), starch (11%), and fat (15%) [97]. Minerals (5.4-10.5%) [98]. Moawad *et al*. [99] reported iron to be 330, zinc 69 and copper 33 mg/100gm. Meanwhile, cumin spent contains 0.28 mg/100gm riboflavin, 0.05 mg/100gm thiamine and 2.07 niacin mg/100gm [100].

Anon [101] and Shaath and Azzo [102] reported that the main constituents of Egyptian cumin seed oil were cuminaldehyde, β –pinene, γ -terpinene, p-mentha-1,3-dien-7-al, p-mentha-1,4-dien-7-al, and p-cymene.



Cuminaldehyde
(Major bioactive compound in *C. cyminum*)

Figure 4 Structure of Curcumin: the Basic Active Substance of *Cuminum cyminum*

8. Health Benefits

Traditional uses of cumin include anti-inflammatory, diuretic, carminative, and anti-spasmodic. It has also been used to treat dyspepsia, jaundice, diarrhea, flatulence, and indigestion. Cuminaldehyde has been demonstrated to scavenge the superoxide anion [103].

Cumin oil and cuminaldehyde have been reported to exhibit strong larvicidal and antibacterial activity. At in vitro concentrations of 300 or 600 ppm, cumin oil inhibited the growth of Lactobacillus plantarum [104]. Cumin oil demonstrated antibacterial activity (reported to be comparable with standard antibiotics) against common human pathogens in in vitro experiments and against gram-negative and gram-positive plant pathogens [105].

Cuminaldehyde, the major constituent of volatile oil, is responsible for the antimicrobial and antimutagenic properties. Spent residue from cumin has the potential as a new source of dietary fiber which can be utilized for incorporation into many food formulations.

8.1. Potential and Current Industrial Applications

Since ancient times, cinnamon has been used worldwide in food preparations and in traditional medicine treatments for, among others, diarrheal, gastrointestinal and colonic diseases, toothaches, oral infections and acne.

Doweidar and Amer [106] produced cookies cinnamon supplemented with 40% legumes flour would contribute (51.68, 56.21%) of the RDA of protein for children and (24.95%, 27.14%) for adults. As for zinc, addition of germinated legumes would contribute (16.40, 10.93%) of the RDA for children and adults. But for iron the contribution (35.40%) for both children and adults.

Alaa El-Dian *et al.* [107] produced healthy biscuits with 5% whole meal black cumin flour or 5% low fat black cumin flour or 50% black cumin oil. Their results showed that the biscuits with 5% black cumin flour (whole meal or low fat) an increase in protein content (10.38 and 10.89%). Meanwhile 50% black cumin oil resulted in a decrease in protein content to 9.42%.

El-Gohery [84] concluded that replacement of wheat flour and barley flour with 40% chickpea powder or 20% sweet lupine powder and 5% turmeric powder improved protein nutritional quality, minerals, total phenolic, flavonoids, and antioxidant activity of the resultant pretzels with acceptable sensory characteristic.

Mohamed *et al.*, [86] observed that supplementation of crackers with 15% sesame seeds and 2% turmeric powder covers up to 48.36% of protein requirement, 32.27% of iron requirement, 45.27% of zinc and 19.10% of calcium. As for vitamins, the crackers cover 5.65% of folate requirements for children 4-8 years. Whereas, crackers cover up to 27.02% of protein requirement, 40.33% of iron requirement, 28.29% of zinc and 11.77% of calcium, for children 9-12 years are shown in Table 6. As for vitamins, the crackers cover 3.77% of folate requirements.

Abdelazim [108] reported the effect of partial substitution with cumin seeds 3% and 5% with or without turmeric powder (0.25%) on chemical composition of pan bread. He illustrated that substitution with 3% cumin seeds protein was 12.57, fat 0.95, fiber 0.64 and ash 1.52. While 5% cumin seeds protein was 12.72, fat 1.69, fiber 0.84 and ash 1.65. As for pan bread with 3% cumin seeds and 0.25% turmeric powder the values were 12.51 protein, 0.94 fat, 0.66 fiber and 1.65 ash. Pan bread with 5% cumin seeds and 0.25% turmeric powder the values was 12.59 protein, 1.68 fat, 0.86 fiber and 1.67 ash. While the use of cumin oil, 0.05% or 0.07% cumin oil with or without turmeric powder (0.25%) to pan bread did not lead to an important change in chemical composition compared with control.

Sharoba *et al*. [109] showed an increase of 88% in iron content after the addition of 3% cumin seeds to batun salat. While zinc increased by 12.61%. Meanwhile the protein content increased from 12.20% to 12.50%.

9. Conclusion

Spices not only add aroma to the food but also give a lot of health benefits and nutritional values. The effect of some common spices on the immune system and human immunity were reported. In this review we listed some bakery products that can be used to improve the immunity of humans.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors have declared that no conflict of interest exists.

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