REVIEW ARTICLE

Opportunities for Health Promotion: Highlighting Herbs and Spices to Improve Immune Support and Well-being

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Abstract

Context: Consuming a balanced and varied diet is beneficial for health, especially when individuals feel stressed, scared, insecure, unequipped, or disempowered from maintaining their health during the COVID-19 pandemic. Nutrient deficiencies from inadequate intake of healthful foods can contribute to a weakened immune system and greater susceptibility to infection. Including herbs and spices in a balanced and diverse diet is one of the highlights of nutritious eating that supports health and immunity.

Objective: The review intended to examine ways to integrate specific herbs and spices into people's diets and to use them therapeutically in holistic, integrated health promotion.

Design: The research team performed a narrative review by searching PubMed Central and Google Scholar databases. The team developed a search strategy focused on specific common names of spices and herbs in combination with other terms, such as health benefits, health promotion, immunity, inflammation.

Setting: This review was conducted in Muncie and Columbus, Indiana.

Results: This review uncovered studies documenting the many therapeutic properties of herbs within the lamiaceae family, particularly basil and spearmint, and spices, including cloves, ginger, and turmeric. Substantial evidence suggests that consumption of a healthful diet, inclusive of herbs and spices, may strengthen the body's immune system against diseases including highly contagious viruses.

Conclusions: With respect to herbs and spices, the current review's findings can help to inform and support future recommendations for a standard within the professions of health to provide an improved, healthier, and well-educated dietary guidance for individuals. More studies are needed on the consumption of herbs and spices in human trials to elicit evidence beyond preclinical and animal studies.

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Introduction

The COVID-19 pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that began in December 2019, has created a shared global concern for health and well-being, with opportunities for health promotion across all cultures and nations. In response, healthcare professionals have been urgently tasked with providing clear and concise messaging around optimal immune function.

The immune system is vitally important to human health. Throughout the spectrum of global public health, many messages of guidance are being given regularly to promote and improve the health and safety of people around the world. Such health promotion messages include guidance related to proper sanitation and hygiene, wearing of masks, physical distancing, regular physical activity, and the importance of healthy food intake.[1,2]

The respiratory symptoms associated with the novel coronavirus COVID-19 occur as a result of a cytokine storm3 that overwhelms the host's immune system with a surging inflammatory response in a very short time. This immune surge sparks a reaction much like that of autoimmune conditions, in which the innate defense systems of the body begin working overtime, damaging internal structures in the attempt to defend against the virus. This results in chronic inflammation3 and progressive health decline.

The inflammatory cytokine reaction is only one molecular response signal and trackable biomarker to determine the health of the body's immune system, and many other factors of relevance to the body's immune response are outside of this review's scope and have been published elsewhere.[4-6] Furthermore, healthcare professionals and emerging research have emphasized the changes to diet and lifestyle behaviors that are related to COVID-19 and to the severity of its symptoms.[7-11]

Many people have been inclined to consume more comfort foods and follow unhealthy dietary practices during these extraordinary times of stress and high uncertainty.[12-15] Generally, these foods are highly processed and have large amounts of added fat, sugar, and sodium.[16,17] Furthermore, stressful experiences during the pandemic may lead to irregular eating patterns,[18,19] increased snacking, and decreased consumption of nutritious foods[20] and beverages, which exacerbate health risks associated with overweight and obesity.[21] Environments of food scarcity, financial insecurity, lockdown, social distancing, and subsequent lack of sleep can further aggravate stress and anxiety, weakening the immune system and compromising the body's natural healing processes and innate recovery potential.

Greater susceptibility to COVID-19 and a poor immune response and recovery have been observed in people with a variety of lifestyle-related, chronic health problems, such as type 2 diabetes, cardiovascular disease, lung disease, certain types of cancer, and weight issues, such as being overweight or obese.[8,21,22] Therefore, maintaining nutritional standards through healthful eating is an important step toward active health promotion in the integrated treatment of health conditions and can help prevent potential future diseases. Supporting the immune system using nutrition, including the herbs and spices identified in this review, should be considered to be a healthy dietary practice that may reduce the predisposition to risk and support overall health and recovery.[16]

Consuming a balanced and varied diet is beneficial for health, especially when individuals feel stressed, scared, insecure, unequipped, or disempowered from maintaining their health during these vulnerable times.[13,15,23] Nutrition can play a vital role in both physical and mental health and may be critically important in immunology.[24,25] Nutrient deficiencies from inadequate intake of healthful foods can contribute to a weakened immune system and greater susceptibility to infection.

As such, the World Health Organization (WHO) encourages the public to consume a variety of fresh and unprocessed foods daily to maximize nutrition and support healthy immunity.[17] They also suggest avoiding excess added sugar, fat, and sodium to lower the risk of health problems and chronic diseases.[26] By following their recommendations many improvements to health and wellbeing can be easily achieved.

As part of a healthy diet, many plants provide a powerful source of nutrition through antioxidants, polyphenols, phytochemicals and other bioactive compounds, together with needed vitamins and minerals. Because the public may continue to choose and consume highly-processed, packaged foods that often lack nutrient density,[27] working nutrition into a well-developed, integrated model of care is important. All clinicians must work collaboratively to implement healthful guidance to help shape and improve the public's overall eating patterns and health status during this COVID-19 pandemic.

Globally, nutritional guidelines focus more on food groups—fruits, vegetables, grains, dairy, meats— rather than herbs and spices—derivatives of plants. Many vital nutrients—such as vitamins A, C, and E; minerals like zinc28; selenium; and iron[5,29]; and other emerging bioactive compounds—such as antioxidants,[30,31] phytochemicals,[32,33] polyphenols, and flavonoids[34,35]—have been explored for their effects in promoting immunity.

Herbs and spices have been used for centuries36 in various parts of the world for food coloring, flavoring, and preserving as well as many for applications in nutrition and medicine. They have been sought after for their many innate health promoting properties, with applications in anti-inflammatory,[37] antiviral,[38-41] antimicrobial, antibacterial, antifungal, wound-healing,[42] antimutagenic, and even anticancer[43,44] treatments.

Generally, herbs and spices comprise many plant parts, including leaves, roots, stems, seeds, berries, buds, bark, or flowers. Variations of these common natural ingredients have been used in cooking[45] and in medicine.[36,46] Although the prevalence of herbs and spices is extensive globally, only in recent years have preclinical and clinical research elaborated on their effectiveness in health promotion.[43]

Also important to note, the Food and Drug Administration (FDA) has recognized herbs and spices as generally recognized as safe (GRAS) for human consumption.[47] Including herbs and spices in a balanced and diverse diet is one of the highlights of nutritious eating that supports health and immunity. They are generally low in calories, sodium, and fat and are devoid of cholesterol.

Although food ingredients contain many of the prophylactic compounds for immunity that are found in herbs and spices, it's interesting to note that many of

contemporary, pharmaceutically produced and broadly prescribed medicines have been engineered through scientific findings about natural plant parts.[48,49] One such example is the commonly prescribed medication to lower blood pressure known as coumadin, which is named after coumarin present in cinnamon.[50]

Naturally, many herbs and spices contain greater levels of bioactive compounds than their synthetic counterparts.[51] Another common spice, ginger, has long been recognized for aiding digestion[52] and has been employed by both the food industry and medicine alike.[53-55] Traditionally, many other herbs and spices have been pursued for their medicinal properties and therapeutic effects including basil, rosemary, cilantro, mint, and turmeric.[56]

Currently, individuals with contemporary eating patterns may remain deficient in the essential nutrients needed for optimal health,[27] and herbs and spices can provide substantial benefits to overall nutrition due to their high concentration of phytonutrients[32,33] and other bioactive compounds.

It has been observed that a large majority of the US population is unaware of the vast health benefits of herbs and spices.[57] The general public and healthcare professionals alike now report a growing interest and desire to learn more about the use of herbs and spices in health promotion.[57-59] Strengthening immune defenses through the regular intake of these ingredients may lead to decreased health risks and could potentially elicit a shortened recovery time. In fact, recent reports have even focused on the use of herbs and spices to reduce the effects of the cytokine cascades of inflammation in the body—similar to those seen in COVID-19 cases—with respect to individuals who are overweight, with metabolic syndrome and obesity.[60,61]

This review intended to examine ways to integrate specific herbs and spices into people's diets and to use them therapeutically in holistic, integrated health promotion. The review addresses ways in which individuals can improve their health and support their immunity. It includes common herbs with a potential impact on immune support, forms of herbs and spices, their influence on overall health status, the prevalence of bioactive compounds, and evidence of supporting research. Lastly, the review discusses the role of clinicians working collaboratively to promote well-being and educate the community about the health benefits of herbs and spices.

Methods

Sparked by collaborative interest in providing tangible insights for nutritional health promotion during the current pandemic, the research team completed a literature search using two databases, PubMed Central and Google Scholar. The team developed a search strategy focused on specific common names of spices—cinnamon, ginger, cloves, turmeric, cumin, chili pepper, paprika, black pepper, garlic, and onions—and herbs—basil, rosemary, sage, thyme, oregano, coriander, spearmint, peppermint, and fenugreek—in combination with other terms such as health benefits, health promotion, immunity, and inflammation. The team also hand-searched and found relevant articles to gain further insight.

Articles met inclusion criteria if they were published in English and were available in both abstract and full-text form, and if the primary focus of the article was herb-and-spice use for medical- or nutritional-health promotion or the implications of herbs and spices within the context of inflammation and immune function.

Articles were excluded if the full text wasn't available or available in English, or if article's focus was on herb-and-spice use in the context of production, processing, harvest, or horticulture.

In addition, reputable information and guidance on the events surrounding COVID-19 were sought by searching presentations, publications, and recommendations put forth by national and global authorities via a search of worldwide websites.

After screening articles, 247 abstracts were reviewed, and 126 articles were deemed relevant and screened using inclusion and exclusion criteria. Of them, 103 articles were included in the review. Due to the heterogeneity of literature reviewed in this report for the diverse herbs and spices covered, the research team further attempted to include the most relevant articles for each herb and spice. The team found notable differences in the previously published literature for specific herbs and spices, such as a large number of studies for cloves and turmeric compared to thyme and cumin.

Results

The reviewed literature revealed that many questions have been asked about herbs and spices, such as how do these natural ingredients provide therapeutic effects, what bioactive compounds exist within them, and what applications may they provide for the future of health and medicine.

The interest about natural ingredient formularies for prevention and treatment for contagious disease is shared globally due to growing antibiotic resistance and other harmful pathogens endangering human health. Furthermore, hundreds, if not thousands, of species of herbs, spices, and medicinal plants have research interest, with a similarly high number of biological compounds and activities expected to be found with effects in human health.

The current review found many investigations for herbs within the lamiaceae family, especially basil[62-67] and spearmint[68-74] as well as spices, including cloves,[75-80] ginger,[81-98] and turmeric.[56,85,99-106] The majority of investigations have focused on the antibacterial, antiviral, anti-inflammatory, and antioxidant potential of herbs and spices. Many other herbs and spices may be of research interest for human health but exist outside of those most commonly consumed ones that this review includes.

The findings of this review underscore the importance of the diet and lifestyle choices needed to promote health and immune support[107] as well as future preventive measures. Maintaining the immune system's healthy functions of regulating environmental factors and responding appropriately through recovery, requires a sufficient supply of essential nutrients for optimal health. As presented in the tables in the review, substantial evidence suggests that consumption of a healthful diet, inclusive of herbs and spices, can strengthen the body's abilities to defend, respond, and recover from diseases such as highly contagious viruses.

Consumption of herbs of spices may be considered to be important to healthy individuals for health promotion across their lifespans. It's important to recognize that the literature reviewed suggests that regular intake of such herbs and spices supports overall immunity and may help prevent illness; the investigation as to whether herbs and spices cure illness is beyond the scope of this review.

Complementary health benefits in the use of herbs and spices for immune support may include a reduction in acute and chronic inflammation,[33,108-110] blood pressure, cholesterol,[111] free-radical damage, and even pain.[112] Mechanisms elucidating these benefits result from the positive impact of directly using herbs and spices and replacing and/or reducing the use of less healthy ingredients in standard cooking, such as high levels of sodium, sugar, saturated fat, and processed oils.[46,113] In particular, herbs and spices have been used to help reduce sodium consumption and lower blood pressure,[114] reducing risks for cardiovascular disease[115] and stroke.[116] Tables 1 and 2 detail these studies as well as additional ones.[117-164]

Additional citations to note that provide comprehensive reports on multiple herbs/spies include:

- Peter, 2012[165]
- Kaefer & Milner, 2008[166]
- Shahidi and Ambigaipalan, 2015[167]
- Kaefer & Milner, 2011[168]
- Yashin et al, 2017[169]
- Shan, et al, 2005[170]
- Lampe, 2003[171]
- Jassim & Naji, 2003[172]

Table 1. Common Herbs Used With Potential Impact for Immune Support. Special attention can be given to the lamiaceae family because these botanical plants are closely related, with similar bioactive compounds; therefore, they should have similar benefits. One of the principle and potent compounds, rosmarinic acid, is shared among this family of herbs. The table highlights the countless potential benefits from antioxidants, polyphenols, phytochemicals, and other constituents of all plant parts. The table doesn't differentiate between method of consumption, cooking, and preparation, but rather spotlights the substantial understanding for the health promoting benefits of eating more herbs and spices. The table also includes garlic and onion because they are commonly used similarity to herbs and spices as well as various teas because they are primarily curated from a mixture of herbs and spices.

Common Name	Binomial Name	Family (botanical)	Herb/Spice; Plant Used	Impact(s) on Immunity / Health Benefit(s)	Bioactive Compound(s)	Research to Support: (Author / year)
Sweet Basil, Holy Basil, Tulsi	Ocimum basilicum L, Ocimum tenuiflorum	Lamiaceae	Herb; fresh and dried leaves and shoots	• Antitumor • Antioxidant • Anti-inflammatory • Antifungal • Antiviral • Antibacterial	D-Linalool, methyl chavicol, eugenol cineole, apigenin, catechins, quercetin, rutin, kaempferol, anthocyanins, limonene, terpinene, carvacrol, geraniol, menthol, safrole, tannins, ursolic, p-coumaric, rosmarinic acids	• Singh et al, 2019[62] • Chiang et al, 2005[63] • Jayasinghe et al, 2003[64] • Grayer et al, 1996[65] • Kadhim et al, 2016[66] • Kubiça et al, 2014[67]
Rosemary	Rosmarinus officinalis L	Lamiaceae	Herb; fresh and dried leaves and shoots	• Antitumor • Antioxidant • Anti-inflammatory	Cineole, borneol, linalool, eucalyptol, camphor, bornyl acetate, α-pinene, camphene, sabinene, phellandrene, α-terpinene, rosmarinic acid, ditarpenes, carnosic acid, carnosol, caffeic acid, limonene rosmanol	• Shin et al, 2013[117] • Shetty, 1997[119] • Chohan et al, 2014[120]

Table 1. (continued)

Common Name	Binomial Name	Family (botanical)	Herb/Spice; Plant Used	Impact(s) on Immunity / Health Benefit(s)	Bioactive Compound(s)	Research to Support: (Author / year)
Sage	Salvia officinalis	Lamiaceae	Herb; fresh and dried leaves and shoots	• Antitumor • Antioxidant • Anti-inflammatory • Antibacterial • Antiviral • Antimicrobial	Thujone, borneol, cineole, bornylesters, α-pinene, camphene, sabinene, limonene, geraniol saponin, catechins, apigenin, luteolin, phellandrene, α-terpinene, rosmarinic acid, caffeic acid, flavonoids	• Shetty, 1997[119] • Chohan et al, 2014[120] • Santoyo et al, 2014[121]
Thyme	Thymus vulgaris L	Lamiaceae	Herb; fresh and dried leaves and shoots	• Antitumor • Antioxidant • Anti-Inflammatory • Anti-Bacterial • Antiviral • Antimicrobial	Thymol, carvacol, linalool, L-borneol, geraniol, amyl alcohol, β-pinene, camphene, p-cymene, caryophyllene, 1,8 cineole	• El-Awady et al, 2014[118] • Koch et al, 2008[81]
Oregano	Origamum vulgare L	Lamiaceae	Herb; fresh and dried leaves, shoots, and flowers	• Antioxidant • Anti-inflammatory • Antibacterial • Antiviral • Antimicrobial	Thymol, carvacrol, α-pinene, cineole, linalyl acetate, linalool, dipentene, p-cymene, β-caryophyllene, carnosic acid, carnosol, caffeic acid, rosmarinic acid, flavonoids, apigegnin, diosmin, luteolin, tannins, camphor, pinene, cineole, quercetin, *p*-coumaric, protocatechuic acid Diosmetin, myricetin	• Shin et al, 2013[117]Santoyo et al, 2014[120] • Meneses et al, 2009[122] • Gilling et al, 2014[123] • Chun et al, 2005[124]
Coriander (Cilantro)	Coriandrum sativum	Apiaceae	Herb; fresh and dried leaves, and fruits	• Antibacterial • Antifungal • Anti-inflammatory • Antispasmodic • Antimicrobial • Antioxidant	D-LinaloolD-α-pinene, β-pinene, α and γ-terpinene, gerciniol, borneol, p-cymene, linalool, carvone, limonene, borneol, geraniol, camphor, and elemol, apigenin, rhamnetin, keampferol, quercetin, vanillic acids, rutin, tocopherols, pyrogallol, terpineol, cumene	• Pathak Nimish et al, 2011[125] • Martins et al, 2016[126] • Nadeem et al, 2013[127]
Spearmint, Peppermint	Mentha spicata, Mentha X piperita	Lamiaceae	Herb; fresh and dried leaves and shoots	• Antimicrobial, antispasmodic, carminative, and antiviral agents • Antioxidant • Antiulcer • Cytoprotective • Hepatoprotective • Cholagogue • Chemopreventive • Anti-inflammatory • Antidiabetogenic	Menthol, menthone, menthyl acetate, β-pinene, α-pinene, sabinene acetate; L-Carvone, terpene, carveol, dihydrocarveol acetate, thujone isomenthone, eriocitrin, hesperidin, apigenin, luteolin, rutin, carotenes, tocopherols, caffeic, rosmarinic, chlorogenic acid	• McKay & Blumberg, 2006[68] • Singh et al, 2015[69] • Mimica-Dukic & Bozin, 2008[70] • Schuhmacher et al, 2003[71] • Mahboubi & Kazempour, 2014[72] • Yarnell et al, 2009[73] • Keifer et al, 2008[74]
Fenugreek	Trigonella foemum graecum	Fabaceae	Spice, Herb; fresh and dried seeds and leaves	• Antiviral, • Antimicrobial • Antitumor • Antioxidant • Anti-inflammatory • Hypotensive • Antidepressant	apigenin, kaempferol, quercetin, vitexin, tricin, naringenin, Sesquiterpenes, aromatic aldehydes, terpenes, saponins	• Wang et al, 2011[128] • Smith, 2003[129] • Yadav & Baquer, 2014[130] • Goyal et al, 2016[131] • Kenny et al, 2013[132]

Table 2. Common Spices Used With Potential Impact for Immune Support

Common Name	Binomial Name	Family (Botanical)	Herb, Spice; Part of Plant Used	Impact(s) on Immunity, Health Benefit(s)	Bioactive Compound(s)	Research to Support: (Author / year)
Cinnamon, Ceylon, Cassia, Saigon	Cinnamomum verum, cassia, loureiroi	Lauraceae	Spice; derived from bark of plant	• Antibacterial • Antimicrobial • Antioxidant • Anti-inflammatory • Antidiabetic • Antifungal • Antiviral	Hydroxycoumarins cinnamaldehyde, cinnamate, cinnamic acid, Eugenol, limonene, terpineol, catechins, proanthocyanidins, tannins, linalool, safrole, pinene, methyleugenol, benzaldehyde	• Marissal-Arvy et al, 2014[75] • Hamidpour et al, 2015[76] • Rao & Gan, 2014[77] • Gunawardena et al, 2014[78] • Moshaverinia et al, 2020[79] • Lee et al, 2011[80]
Ginger	Zingiber officinale Roscoe	Zingiberaceae	Spice; rhizome fresh and dried spice	• Anti-inflammatory • Antimicrobial • Antibacterial • Antioxidant • Antitumor • Antiplatelet formation • Antiviral • Immunomodulatory	Gingerol, paradol, shogaols, zingerone, hydoxyphenylpropenes, vallinoids, geraniol, geranial, borneol, linalool, camphene, zingerol, zingiberon	• Koch et al, 2008[81] • Shukla & Singh, 2007[82] • Prasad & Tyagi, 2015[83] • Chrubasik et al, 2005[84] • Ramadan et al, 2011[85] • Lantz et al, 2007[86]
Cloves	Syzygium aromaticum	Myrtaceae	Spice; flower bud	• Antibacterial • Antimicrobial • Antioxidant • Anti-inflammatory • Analgesic • Antifungal • Anticancer	Eugenol, dehydroeugenol sesquiterpenes, caryophyllene, tannins, isoeugenol acetyleugenol pinene, vanillin, gallic acid, flavonoids, phenolic acids	• Cai & Wu, 1996[87] • Aman et al, 2020[88] • Cortés-Rojas et al, 2014[89] • Aboubakr et al, 2016[90] • Khalil et al, 2017[91] • Mittal et al, 2014[92] • Kamatou et al, 2012[93] • Rodrigues et al, 2009[94] • Lee et al, 2007[95] • Pramod et al, 2010[96] • Benencia & Courrèges, 2000[97] • Batiha et al, 2020[98]
Turmeric	*Curcuma longa L.*	Zingiberaceae	Spice; rhizome fresh and dried spice	• Anti-inflammatory • Antimicrobial • Antibacterial, antioxidant • Antitumor	Curcuminoids, demethoxycurcumin, bisdemethoxycurcumin, tetrahydrocurcumin, eugenol, carotene, ascorbic acid, caffeic, *p*-coumaric, protocatechuic, syringic, vanillic acid	• Chattopadhyay et al, 2004[56] • Ramadan et al, 2011[99] • Chearwae et al, 2006[100] • Rajkumari & Sanatombi, 2017[101] • Chandrasekaran et al, 2013[102] • Abdel-Lateef et al, 2016[103] • Liu & Nair, 2012[104] • Khajehdehi, 2012[105] • Mounce et al, 2017[106] • Zorofchian Moghadamtousi et al, 2014[107]
Cumin, black cumin, black seed	Cuminum cyminum L. Nigella sativa L.	Apiaceae	Spice; seeds	• Antimicrobial • Antioxidant • Anticancer • Antitumor • Antifungal • Antibacterial • Anti-inflammatory	Coumarins, cumin aldehyde, cuminal, β-pinene, γ-terpinene, safranal, quercetin, p-coumaric, rosmarinic, trans-2-dihydrocinnamic acids flavanoids	• Randhawa & Alghamdi, 2011[133] • Hassanien et al, 2015[134] • Singh et al, 2014[135] • Bourgou et al, 2010[136]

Table 2. (continued)

Common Name	Binomial Name	Family (Botanical)	Herb, Spice; Part of Plant Used	Impact(s) on Immunity, Health Benefit(s)	Bioactive Compound(s)	Research to Support: (Author / year)
Chili pepper, paprika	Capsicum annuum, Capsicum frutescens	Solanaceae	Spice; seed and fruit	• Antimicrobial • Chemo-preventative • Analgesic • Antioxidant • Anticancer • Antifungal • Antiviral	Capsaicin, tocopherol, lutein, carotene, capsanthin, quercetin, ascorbic acid, rutin	• Sun et al, 2007[137] • Khan et al, 2014[138] • Bourne et al, 1999[139] • Spiller et al, 2008[140] • Beltran et al, 2007[141] • Takano et al, 2007[142] • Parvez, 2007[143]
Black pepper	Piper nigrum L	Piperaceae	Spice; Dried fruit berries	• Antioxidant • Anti-inflammatory • Anticancer • Antimicrobial • Antibacterial • Antipyretic • Analgesic • Enhanced bioavailability of other nutrients	β-pinene, piperine, oleoresins, piperolein, β-caryophyllene, limonene, lignans, alkaloids, flavonoids, myristic acid, myristicin, citral, palmitic acid, piperine, terpinen-4-ol and ubiquinone, lauric acid	• Meghwal & Goswami, 2012[144] • Meghwal & Goswami, 2013[145] • Ahmad et al, 2012[146] • Kapoor et al, 2009[147] • Srinivasan, 2007[148]
Garlic	Allium sativum	Amaryllidaceae	Fresh and Dried; fruit, bulb	• Antibacterial • Antifungal • Antiviral • Antimicrobial • Antitumor • Antihypertensive • Cardioprotective • Antidiabetic • Anticancer • Anti-Obesity • Immunomodulatory	D-Linalool, Methyl chavicol, eugenol cineole, Allyl sulfides, allicin, ajoene, S-allyl-L-cysteine (SAC)	• Borek, 2001[149] • Butt et al, 2009[150] • Bayan et al, 2013[151] • Ryu & Kang, 2017[152] • Sultana et al, 2016[153] • Bjarnsholt et al, 2005[154]
Onion	Allium cepa	Amaryllidaceae	Fresh and Dried; fruit, bulb	• Antibacterial • Antifungal • Antiviral • Antimicrobial	Quercetin, kaempferol, myricetin, and catechin, apigenin, dipyridyl disulfide, rutin, quercetin-4-glucoside	• Santas et al, 2010[155] • Shim et al, 2011[156]
Various teas	Camellia sinensis	Theaceae	Fresh and Dried; leaves, stems, shoots, flowers	• Antioxidative (Various) • Reduced cholesterol • Anti-inflammatory • Antiviral • Antibacterial • Antifungal	Quercetin, kaempferol, catechin, gallocatechin, epicatechin, epigallocatechin gallate theaflavins, myricetin	• Dreosti, 1996[157] • Xu et al, 2017[158] • Furushima et al, 2018[159] • Joubert & Ferreira, 1996[160] • Ravikumar, 2014[161] • Senanayake, 2013[162] • Ide et al, 2016[163] • Khan & Mukhtar, 2018[164]

Discussion

Guidance for the relationship between nutrition and health can act as primary prevention and help reduce some of the more significant risk factors for viral infections, such as COVID-19. Those at increased risk of infection include the elderly and those with underlying comorbidities[10,12] related to diet and lifestyle. With the goal of improving human defenses against viral susceptibility and promoting overall healthy living, reducing obesity and diabetes,[61-175] and supporting the immune system, the current review examined a series of herbs and spices that healthcare professionals can advise and inspire individuals to include in their regular eating patterns.

Supporting the role of nutrition in disease prevention, the Centers for Disease Control and Prevention (CDC), WHO, and the Academy of Nutrition and Dietetics have further published information on ways to promote optimal immune function and overall good health by following nutritional recommendations, staying active, having fun in the kitchen, and prioritizing mental health.[1,2,175]

For consumers to benefit from the opportunity to incorporate integrative and inclusive support for diet and lifestyle recommendations, the role of education and expertise in the jobs of healthcare professionals is key. Interest is growing in understanding intricate and accurate nutritional-health aspects regarding which herbs and spices can offer benefits to immunity, and the knowledge is important for all medical and allied health care professionals, such as registered nurses, primary care physicians, psychologists, osteopaths, mental health counselors, registered dietitian nutritionists, and social workers. The effort of working collaboratively through complementary care models to provide comprehensive care for individuals and families is crucial, especially during the pandemic.[176]

Integrative healthcare prioritizes the use of a patient-centered approach in which the whole person is treated comprehensively by a well-coordinated care team. A central part of patient-centered care is listening to the patient's perspective and amplifying his or her voice versus prescribing care in an authoritative manner.[176]

In recent years, the focus has increasingly been on complementary, alternative, and integrative medicine approaches. During the current pandemic, the public is continuously seeking information related to prevention and treatment from all sources. It's then advantageous for healthcare professionals to communicate effectively and share knowledge and understanding related to the use of herbs and spices to support immunity, regardless of whether the scope of their practice falls more within the conventional versus complementary and alternative spectrums.

If healthcare professionals are able to share the many health benefits of herbs and spices and the methods by which they can be routinely incorporated, clients and patients can feel encouraged and empowered in their understanding of which herbs and spices they can include in their diets and why.

Tables 1 and 2 can be used as a resource for nutrition and healthcare professionals at large, who can familiarize themselves with many of the common herbs and spices and can instruct individuals on divergence from typical eating patterns, with opportunities to highlight regular intake to promote good health and boost immunity. A wide variety of advances in food and nutrition insight are readily available in collaborative and complementary, health promotional practice as well as inclusive communication strategies for professionals. All of these suggestions may help strengthen confidence and competence for individuals interested in improving their health through food and nutrition. From regular consumption to specific medical applications, herbs and spices deserve a place on the plates of all eaters.

As the future of nutrition science continues to evolve with rapidly advancing technology and research, the current research team expects further incorporation of beneficial herbs and spices to be included in general nutrition guidance. It's anticipated that future research will focus on identification of genetic expressions known to provide greater defense or greater risk for viral infections.[38]

The future will also likely see more interest in investigations for natural-medicine modalities and opportunities to discover even more bioactive compounds and plant properties that are important for promoting optimal health and longevity.[49,172] Similarly, the future will see a high desire on the part of the public and of particular population groups to alter their eating patterns across their lifespans, toward improvement of potential health defenses and disease prevention post-COVID-19, in expectation of future infectious diseases.

Observational data and epidemiological trends will demonstrate just how important healthy eating patterns are for human health and well-being. The particular expertise of a complementary healthcare team is warranted during this extraordinary time in history.

It's clear that the role of food and nutrition in reducing the risk of infection and promoting health and recovery shouldn't be overlooked. The power to prevent infection and promote optimal immune function is available. Additionally, providing accessible, supplementary guidance may help to lessen fears and panic and improve overall mental and emotional health while providing physical-health benefits.

Consequently, future guidance may include regular and routine use of particular food ingredients, such as distinctive herbs and spices, known to promote their excellent prophylactic effects.[38-40,172] Nutritional guidance for optimal immune function can help improve global prevention of infection as well as act to help treat and reverse a wide range of common comorbidities that tend to make individuals more susceptible to infectious disease.

This review has several limitations that should be considered, such as the absence of substantial previous research on the topics of nutritional science that focused

on herbs and spices with special attention to immune function. Likewise, little is known about the specific novel coronavirus, COVID-19, at this time, although health professionals continue to understand more each day. Therefore, this review can't speak to specificity of prevention or treatment for SARS-CoV-2, but it does substantiate the need for investigations.

In addition to using herbs and spices to boost immunity and prevent disease, emerging research from around the globe highlights many natural compounds found in herbs and spices as potential therapeutic options to complement medical treatment for the novel coronavirus SARS-CoV-2 as they have been explored for their effects on mitigating COVID-19[177-181] and similar coronaviruses.[182-186]

Another limitation of the study is the general lack of funding for natural and complementary medicine modalities, such as the potential reason for the lack of inclusion of herbs and spices in generic, public health nutritional guidance. Lastly, due to the sheer number of botanical plants with theorized or validated, previously investigated or yet to be discovered benefits, the authors couldn't include a high volume of the different herbs and spices known in different regions and cultures around the world. Thus, it would be wise to work with local experts in nutritional science, botanical medicine, and functional foods to learn more about the health benefits of specific herbs and spices beyond the context of this review. Collaborative communication to the public can provide encouragement and confidence to consumers for simple strategies to support optimal health and immunity.

Conclusions

With respect to herbs and spices, the current review's findings can help to inform and support future recommendations for a standard within the professions of health to provide an improved, healthier, and well-educated dietary guidance for individuals. More studies are needed on the consumption of herbs and spices in human trials to elicit evidence beyond preclinical and animal studies.

Medical Disclaimer

The authors don't suggest the use of any food ingredients, botanicals, herbs, spices, or otherwise as replaceable treatment options to any standard medical care but offer this review as complementary guidance with integrated support with qualified medical professionals and health educators, who are highly trained and experienced in health promotion and disease prevention.

Authors' disclosure Statement

Authors declare that they have no conflicts of interest related to this review.

References

1. Academy of Nutrition and Dietetics. Coronavirus (COVID-19): Follow these tips to help keep your family safe. 2020. Accessed May 16, 2020, from https://www.eatright.org/coronavirus
2. Centers for Disease Control and Prevention. How to protect yourself and others. April 24, 2020. Accessed May 16, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html
3. Mehta P, McAuley DF, Brown M, Sanchez E, Tattersall RS, Manson JJ. COVID-19: Consider cytokine storm syndromes and immunosuppression. *The Lancet.* 2020; 395(10229): 1033-1034.
4. Prompetchara E, Ketloy C, Palaga T. Immune responses in COVID-19 and potential vaccines: Lessons learned from SARS and MERS epidemic. *Asian Pac J Allergy Immunol.* 2020 Mar; 38(1):1-9.
5. Yanuck SF, Pizzorno J, Messier H, Fitzgerald KN. Evidence supporting a phased immuno-physiological approach to COVID-19 from prevention through recovery. *Integrative Medicine: A Clinician's Journal.* 2020; 19(1). Epub ahead of print. Accessed May 24, 2020, from http://imjournal.com/oa/evidence_supporting-a_phased_immuno-physiological_approach_to_covid-19_from_prevention_through_recovery/
6. Arshad Ali S, Baloch M, Ahmed N, Arshad Ali A, Iqbal A. The outbreak of Coronavirus Disease 2019 (COVID-19) - An emerging global health threat. *Journal of Infection and Public Health.* 2020; 13(4):644–646. https://doi.org/10.1016/j.jiph.2020.02.033.
7. Richardson S, Hirsch JS, Narasimhan M, Crawford JM, McGinn T, Davidson KW, et al. Presenting characteristics, comorbidities, and outcomes among 5700 patients hospitalized with COVID-19 in the New York City area. *JAMA.* 2020.
8. Yang J, Zheng Y, Gou X, Pu K, Chen Z, Guo Q, et al. Prevalence of comorbidities in the novel Wuhan coronavirus (COVID-19) infection: A systematic review and meta-analysis. *International Journal of Infectious Diseases.* 2020; 94:91-95. https://doi.org/10.1016/j.ijid.2020.03.017
9. Jain V, Yuan JM. Systematic review and meta-analysis of predictive symptoms and comorbidities for severe COVID-19 infection. *medRxiv.* 2020.
10. Centers for Disease Control and Prevention. At risk for severe illness. May 14, 2020. Accessed May 16, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/groups-at-higher-risk.html
11. Garg S, Kim L, Whitaker M, O'Halloran A, Cummings C, Holstein R, et al. Hospitalization rates and characteristics of patients hospitalized with laboratory-confirmed coronavirus disease 2019-COVID-NET, 14 states. March 1-30, 2020. *MMWR.* 2020; 69(15), 458.
12. Oliver G, Wardle J. Perceived effects of stress on food choice. *Physiology & Behavior.* 1999; 66(3):511-515.
13. Kandiah J, Yake M, Jones J, Meyer M. Stress influences appetite and comfort food preferences in college women. *Nutrition Research.* 2006: 26(3):118-123.
14. Born JM, Lemmens SG, Rutters F, Nieuwenhuizen AG, Formisano E, Goebel R, Westerterp-Plantenga MS. Acute stress and food-related reward activation in the brain during food choice during eating in the absence of hunger. *International Journal of Obesity.* 2010; 34(1):172-181.
15. Oliver G, Wardle J, Gibson EL. Stress and food choice: A laboratory study. *Psychosomatic Medicine.* 2000; 62(6):853-865.
16. Food and Agriculture Organization of the United Nations. Maintaining a healthy diet during the COVID-19 pandemic. March 27, 2020. Rome. Accessed May 25, 2020, from https://doi.org/10.4060/ca8380en
17. World Health Organization, Regional Office for Europe. Food and nutrition tips during self-quarantine. March 27, 2020. Accessed May 25, 2020, from http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/technical-guidance/food-and-nutrition-tips-during-self-quarantine
18. Macht M. How emotions affect eating: a five-way model. *Appetite.* 2008; 50(1):1-11.
19. Macht M. Characteristics of eating in anger, fear, sadness, and joy. *Appetite.* 1999; 33(1):129-139.
20. Anton SD, Miller PM. Do negative emotions predict alcohol consumption, saturated fat intake, and physical activity in older adults? *Behavior Modification.* 2005; 29(4):677-688.
21. Maffetone PB, Laursen PB. The perfect storm: Coronavirus (Covid-19) pandemic meets overfat pandemic. *Frontiers in Public Health.* 2020: 8:135.
22. Zhu L, She ZG, Cheng X, Qin JJ, Zhang XJ, Cai J, et al. Association of blood glucose control and outcomes in patients with COVID-19 and pre-existing type 2 diabetes. *Cell Metabolism.* 2020; 31:1068–1077. https://doi.org/10.1016/j.cmet.2020.04.021
23. Laitinen J, Ek E, Sovio U. Stress-related eating and drinking behavior and body mass index and predictors of this behavior. *Preventive Medicine.* 2002; 34(1):29-39.
24. Cunningham-Rundles S, McNeeley DF, Moon A. Mechanisms of nutrient modulation of the immune response. *Journal of Allergy and Clinical Immunology.* 2005; 115(6):1119-1128.
25. Ponton F, Wilson K, Cotter SC, Raubenheimer D, Simpson SJ. Nutritional immunology: A multi-dimensional approach. *PLoS Pathogens.* 2011; 7(12):e1002223. https://doi.org/10.1371/journal.ppat.1002223
26. World Health Organization, Regional Office for Eastern Mediterranean. Nutrition advice for adults during the COVID-19 outbreak. 2020. Accessed May 25, 2020, from http://www.emro.who.int/nutrition/nutrition-infocus/nutrition-advice-for-adults-during-the-covid-19-outbreak.html
27. Popkin BM. Nutrition transition and the global diabetes epidemic. *Current Diabetes Reports.* 2015; 15(9):64.
28. Read SA, Obeid S, Ahlenstiel C, Ahlenstiel G. The role of zinc in antiviral immunity. *Advances in Nutrition.* 2019; 10(4)696-710.

29. Calder PC, Carr AC, Gombart AF, Eggersdorfer M. Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. *Nutrients.* 2020; 12(4):1181.
30. Carlsen MH, Halvorsen BL, Holte K, Bøhn SK, Dragland S, Sampson L, et al. The total antioxidant content of more than 3100 foods, beverages, spices, herbs, and supplements used worldwide. *Nutrition Journal.* 2010; 9(1):3.
31. Wilson DW, Nash P, Buttar HS, Griffiths K, Singh R, De Meester F, et al. The role of food antioxidants, benefits of functional foods, and influence of feeding habits on the health of the older person: An overview. *Antioxidants.* 2017; 6(4):81. http://dx.doi.org/10.3390/antiox6040081
32. Dietz BM, Hajirahimkhan A, Dunlap TL, Bolton JL. Botanicals and their bioactive phytochemicals for Women's health. *Pharmacological Reviews.* 2016; 68(4):1026-1073. doi:10.1124/pr.115.010843
33. Islam MA, Alam F, Solayman M, Khalil MI, Kamal MA, Gan SH. Dietary phytochemicals: Natural swords combating inflammation and oxidation-mediated degenerative diseases. *Oxidative Medicine and Cellular Longevity.* 2016; 5137431-25. doi:10.1155/2016/5137431
34. Zakaryan H, Arabyan E, Oo A, Zandi K. Flavonoids: Promising natural compounds against viral infections. *Archives of Virology.* 2017; 162(9):2539-2551. https://doi.org/10.1007/s00705-017-3417-y
35. Cushnie TT, Lamb AJ. Recent advances in understanding the antibacterial properties of flavonoids. *International Journal of Antimicrobial Agents.* 2011; 38(2):99-107.
36. Craig WJ. Health-promoting properties of common herbs. *The American Journal of Clinical Nutrition.* 1999; 70(3):491s-499s.
37. Bashir Dar K, Hussain Bhat A, Amin S, Masood A, Afzal Zargar M, Ahmad Ganie S. Inflammation: a multidimensional insight on natural anti-inflammatory therapeutic compounds. *Current Medicinal Chemistry.* 2016; 23(33):3775-3800.
38. Dhama K, Karthik K, Khandia R, Munjal A, Tiwari R, Rana R, et al. Medicinal and therapeutic potential of herbs and plant metabolites/extracts countering viral pathogens-current knowledge and future prospects. *Current Drug Metabolism.* 2018; 19(3):236-263.
39. Akram M, Tahir IM, Shah SMA, Mahmood Z, Altaf A, Ahmad K, et al. Antiviral potential of medicinal plants against HIV, HSV, influenza, hepatitis, and coxsackievirus: A systematic review. *Phytotherapy Research.* 2018: 32(5):811-822.
40. Ben-Shabat S, Yarmolinsky L, Porat D, Dahan A. Antiviral effect of phytochemicals from medicinal plants: Applications and drug delivery strategies. *Drug Delivery and Translational Research.* 2020; 10(2):354–367. https://doi.org/10.1007/s13346-019-00691-6
41. Jo S, Kim S, Shin DH, Kim MS. Inhibition of African swine fever virus protease by myricetin and myricitrin. *Journal of Enzyme Inhibition and Medicinal Chemistry.* 2020; 35(1):1045–1049. https://doi.org/10.1080/14756366.2020.1754813
42. Shedoeva A, Leavesley D, Upton Z, Fan C. Wound healing and the use of medicinal plants. *eCAM.* 2019; 2684108. https://doi.org/10.1155/2019/2684108
43. Srinivasan K. Antimutagenic and cancer preventive potential of culinary spices and their bioactive compounds. *PharmaNutrition.* 2017; 5(3):89-102.
44. Dhandapani KM, Mahesh VB, Brann DW. Curcumin suppresses growth and chemoresistance of human glioblastoma cells via AP-1 and NFκB transcription factors. *Journal of Neurochemistry.* 2007; 102(2):522-538.
45. Sherman PW, Billing J. Darwinian gastronomy: Why we use spices: Spices taste good because they are good for us. BioScience. 1999; 49(6):453-463.
46. Tapsell LC, Hemphill I, Cobiac L, Sullivan, DR, Fenech, M, Patch, CS, et al. Health benefits of herbs and spices: The past, the present, the future. *Medical Journal of Australia.* 2006; 185(S4):S1-S24.
47. Office of Regulatory Affairs: Center for Food Safety and Applied Nutrition. CPG Sec 525.750 Spices - Definitions. August 24, 2018. Accessed May 25, 2020, from https://www.fda.gov/regulatory-information/search-fda-guidance-documents/cpg-sec-525750-spices-definitions
48. Kähkönen MP, Hopia AI, Vuorela HJ, Rauha JP, Pihlaja K, Kujala TS, Heinonen M. Antioxidant activity of plant extracts containing phenolic compounds. *Journal of Agricultural and Food Chemistry.* 1999; 47(10):3954-3962.
49. Yuan H, Ma Q, Ye L, Piao G. The traditional medicine and modern medicine from natural products. *Molecules.* 2016; 21(5):559. https://doi.org/10.3390/molecules21050559
50. Blahová J, Svobodová Z. Assessment of coumarin levels in ground cinnamon available in the Czech retail market. *The Scientific World Journal.* 2012; 263851. https://doi.org/10.1100/2012/263851
51. Suhaj M. Spice antioxidants isolation and their antiradical activity: A review. *Journal of Food Composition and Analysis.* 2006; 19(6-7):531-537.
52. Prasad S, Tyagi AK. Ginger and its constituents: Role in prevention and treatment of gastrointestinal cancer. *Gastroenterology Research and Practice.* 2015; 142979-11. doi:10.1155/2015/142979
53. Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, Linder T, Wawrosch C, Uhrin P, et al. Discovery and resupply of pharmacologically active plant-derived natural products: A review. *Biotechnology Advances.* 2015; 33(8):1582-1614.
54. Mowrey D, Clayson D. Motion sickness, ginger, and psychophysics. *The Lancet.* 1982; 319(8273);655-657.
55. White B. Ginger: An overview. *American Family Physician.* 2007; 75(11):1689-1691.
56. Chattopadhyay I, Biswas K, Bandyopadhyay U, Banerjee RK. Turmeric and curcumin: Biological actions and medicinal applications. *Current Science-Bangalore.* 2004; 87(1):44-53.
57. Kandiah J, Wesley J, Khubchandani J. Registered dietitians' perspectives and practices on complementary and alternative medicine. *Current Developments in Nutrition.* 2019; 3(S1).
58. Isbill J, Kandiah J, Khubchandani J. Use of ethnic spices by adults in the United States: An exploratory study. *Health Promotion Perspectives.* 2018; 8(1):33.
59. Tulunay M, Aypak C, Yikilkan H, Gorpelioglu S. Herbal medicine use among patients with chronic diseases. Journal of Intercultural Ethnopharmacology. 2015; 4(3):217.
60. Panahi Y, Hosseini MS, Khalili N, Naimi E, Simental-Mendía LE, Majeed M, Sahebkar A. Effects of curcumin on serum cytokine concentrations in subjects with metabolic syndrome: A post-hoc analysis of a randomized controlled trial. *Biomedicine & Pharmacotherapy.* 2016; 82:578-582. doi:10.1016/j.biopha.2016.05.037
61. Oh ES, Petersen KS, Kris-Etherton PM, Rogers CJ. Spices in a high-saturated-fat, high-carbohydrate meal reduce postprandial proinflammatory cytokine secretion in men with overweight or obesity: A 3-period, crossover, randomized controlled trial. *The Journal of Nutrition.* 2020; nxaa063. https://doi.org/10.1093/jn/nxaa063
62. Singh P, Chakraborty P, He DH, Mergia A. Extract prepared from the leaves of Ocimum basilicum inhibits the entry of Zika virus. *Acta Virologica.* 2019; 63(3):316-321. doi:10.4149/av_2019_307
63. Chiang L, Ng L, Cheng P, Chiang W, Lin C. Antiviral activities of extracts and selected pure constituents of ocimum basilicum. *Clinical and Experimental Pharmacology and Physiology.* 2005; 32(10):811-816. doi:10.1111/j.1440-1681.2005.04270.x
64. Jayasinghe C, Gotoh N, Aoki T, Wada S. Phenolics composition and antioxidant activity of sweet basil (Ocimum basilicum L). *Journal of Agricultural and Food Chemistry.* 2003; 51(15):4442-4449.
65. Grayer RJ, Bryan SE, Veitch NC, Goldstone FJ, Paton A, Wollenweber E. External flavones in sweet basil, Ocimum basilicum, and related taxa. *Phytochemistry.* 1996; 43(5):1041-1047.
66. Kadhim MJ, Sosa AA, Hameed IH. Evaluation of anti-bacterial activity and bioactive chemical analysis of Ocimum basilicum using Fourier transform infrared (FT-IR) and gas chromatography-mass spectrometry (GC-MS) techniques. *Journal of Pharmacognosy and Phytotherapy.* 2016; 8(6):127-146.
67. Kubiça TF, Alves SH, Weiblen R, Lovato LT. In vitro inhibition of the bovine viral diarrhea virus by the essential oil of Osmium basilicum (basil) and monoterpenes. *Brazilian Journal of Microbiology.* 2014; 45(1):209-214
68. McKay DL, Blumberg JB. A review of the bioactivity and potential health benefits of peppermint tea (Mentha piperita L). *Phytotherapy Research.* 2006; 20(8):619-633.
69. Singh R, Shushni MA, Belkheir A. Antibacterial and antioxidant activities of Mentha piperita L. *Arabian Journal of Chemistry.* 2015; 8(3)322-328.
70. Mimica-Dukic N, Bozin B. Mentha L species (Lamiaceae) as promising sources of bioactive secondary metabolites. *Current Pharmaceutical Design.* 2008; 14(29):3141-3150.
71. Schuhmacher A, Reichling J, Schnitzler P. Virucidal effect of peppermint oil on the enveloped virus herpes simplex virus type 1 and type 2 in vitro. *Phytomedicine: International Journal of Phytotherapy and Phytopharmacology.* 2003; 10(6-7):504-510. https://doi.org/10.1078/094471103322331467
72. Mahboubi M, Kazempour N. Chemical composition and antimicrobial activity of peppermint (Mentha piperita L) essential oil. *Songklanakarin J. Sci. Technol.* 2014; 36(1):83-87.
73. Yarnell E, Abascal K, Rountree R. Herbs for herpes simplex infections. *Alternative and Complementary Therapies.* 2009; 15(2):69-74.
74. Keifer D, Ulbricht C, Abrams TR, Basch E, Giese N, Giles M, et al. Peppermint (Mentha Xpiperita) An evidence-based systematic review by the natural standard research collaboration. *Journal of Herbal Pharmacotherapy.* 2008; 7(2):91-143.
75. Marissal-Arvy N, Batandier C, Dallennes J, Canini F, Poulet L, Couturier K, et al. Effect of a high-fat-high-fructose diet, stress and cinnamon on central expression of genes related to immune system, hypothalamic-pituitary-adrenocortical axis function and cerebral plasticity in rats. *The British Journal of Nutrition.* 2014; 111(7):1190-201.
76. Hamidpour R, Hamidpour M, Hamidpour S, Shahlari M. Cinnamon from the selection of traditional applications to its novel effects on the inhibition of angiogenesis in cancer cells and prevention of Alzheimer's disease, and a series of functions such as antioxidant, anticholesterol, antidiabetes, antibacterial, antifungal, nematicidal, acaracidal, and repellent activities. *Journal of Traditional and Complementary Medicine.* 2015; 5(2):66–70. https://doi.org/10.1016/j.jtcme.2014.11.008

77. Rao PV, Gan SH. Cinnamon: A multifaceted medicinal plant. Evidence-based *Complementary and Alternative Medicine: eCAM.* 2014; 642942. https://doi.org/10.1155/2014/642942
78. Gunawardena D, Govindaraghavan S, Münch G. Anti-inflammatory properties of cinnamon polyphenols and their monomeric precursors. *Polyphenols in Human Health and Disease.* 2014; 409-425. https://doi.org/10.1016/B978-0-12-398456-2.00030-X
79. Moshaverinia M, Rastegarfar M, Moattari A, Lavaee F. Evaluation of the effect of hydro alcoholic extract of cinnamon on herpes simplex virus-1. *Dental Research Journal.* 2020; 17(2):114–119.
80. Lee B, Kim Y, Cho D, Sohn N, Kang H. Immunomodulatory effect of water extract of cinnamon on anti-CD3-induced cytokine responses and p38, JNK, ERK1/2, and STAT4 activation. *Immunopharmacology and Immunotoxicology.* 2011; 33(4):714-722. doi:10.3109/08923973.2011.564185
81. Koch C, Reichling J, Schneele J, Schnitzler P. Inhibitory effect of essential oils against herpes simplex virus type 2. *Phytomedicine.* 2008; 15(1-2):71–78. https://doi.org/10.1016/j.phymed.2007.09.003
82. Shukla Y, Singh M. Cancer preventive properties of ginger: A brief review. Food and Chemical Toxicology. 2007; 45(5)683–690. https://doi.org/10.1016/j.fct.2006.11.002
83. Prasad S, Tyagi AK. Ginger and its constituents: Role in prevention and treatment of gastrointestinal cancer. *Gastroenterology Research and Practice.* 2015; 142979-11. doi:10.1155/2015/142979
84. Chrubasik S, Pittler MH, Roufogalis BD. Zingiberis rhizoma: A comprehensive review on the ginger effect and efficacy profiles. *Phytomedicine.* 2005; 12(9):684-701.
85. Ramadan G, Al-Kahtani MA, El-Sayed WM. Anti-inflammatory and anti-oxidant properties of Curcuma longa (turmeric) versus Zingiber officinale (ginger) rhizomes in rat adjuvant-induced arthritis. *Inflammation.* 2011; 34(4):291–301. https://doi.org/10.1007/s10753-010-9278-0
86. Lantz RC, Chen GJ, Sarihan M, Sólyom AM, Jolad SD, et al. The effect of extracts from ginger rhizome on inflammatory mediator production. *Phytomedicine.* 2007; 14(2):123-128. doi:10.1016/j.phymed.2006.03.003
87. Cai L, Wu CD. Compounds from Syzygium aromaticum possessing growth inhibitory activity against oral pathogens. *Journal of Natural Products.* 1996; 59(10):987-990.
88. Aman RM, Hashim IIA, Meshali MM. Novel Clove essential oil nanoemulgel tailored by Taguchi's model and scaffold-based nanofibers: Phytopharmaceuticals with promising potential as cyclooxygenase-2 inhibitors in external inflammation. *International Journal of Nanomedicine.* 2020; 15:2171. https://doi.org/10.2147/IJN.S246601
89. Cortés-Rojas DF, de Souza CRF, Oliveira WP. Clove (Syzygium aromaticum): A precious spice. *Asian Pacific Journal of Tropical Biomedicine.* 2014; 4(2):90-96.
90. Aboubakr H, Nauertz A, Luong N, Agrawal S, El-Sohaimy S, Youssef M, Goyal S. In vitro antiviral activity of clove and ginger aqueous extracts against feline calicivirus, a surrogate for human norovirus. *Journal of Food Protection.* 2016; 79(6):1001-1012. doi:10.4315/0362-028X.JFP-15-593
91. Khalil AA, ur Rahman U, Khan MR, Sahar A, Mehmood T, Khan M. Essential oil eugenol: Sources, extraction techniques and nutraceutical perspectives. *RSC Advances.* 2017; 7(52):32669-32681.
92. Mittal M, Gupta N, Parashar P, Mehra V, Khatri M. Phytochemical evaluation and pharmacological activity of Syzygium aromaticum: A comprehensive review. *International Journal of Pharmacy and Pharmaceutical Sciences.* 2014; 6(8):67-72.
93. Kamatou GP, Vermaak I, Viljoen AM. Eugenol - from the remote Maluku Islands to the international marketplace: A review of a remarkable and versatile molecule. *Molecules.* 2012; 17(6):6953-6981.
94. Rodrigues TG, Fernandes A Jr, Sousa JP, Bastos JK, Sforcin JM. In vitro and in vivo effects of clove on pro-inflammatory cytokines production by macrophages. *Natural Product Research.* 2009; 23(4):319–326.
95. Lee YY, Hung SL, Pai SF, Lee YH, Yang SF. Eugenol suppressed the expression of lipopolysaccharide-induced proinflammatory mediators in human macrophages. *Journal of Endodontics.* 2007; 33(6):698–702. https://doi.org/10.1016/j.joen.2007.02.010
96. Pramod K, Ansari SH, Ali J. Eugenol: a natural compound with versatile pharmacological actions. *Natural Product Communications.* 2010; 5(12):1999-2006.
97. Benencia F, Courrèges MC. In vitro and in vivo activity of eugenol on human herpesvirus. *Phytotherapy Research: PTR.* 2000; 14(7):495–500. https://doi.org/10.1002/1099-1573(200011)14:7<495::aid-ptr650>3.0.co;2-8
98. Batiha GE, Alkazmi LM, Wasef LG, Beshbishy AM, Nadwa EH, Rashwan EK. Syzygium aromaticum L. (Myrtaceae): Traditional uses, bioactive chemical constituents, pharmacological and toxicological activities. *Biomolecules.* 2020; 10(2):202. https://doi.org/10.3390/biom10020202
99. Chearwae W, Chearwae W, Wu C, Wu C, Chu H, Chu H, et al. Curcuminoids purified from turmeric powder modulate the function of human multidrug resistance protein 1 (ABCC1). *Cancer Chemotherapy and Pharmacology.* 2006; 57(3):376-388. doi:10.1007/s00280-005-0052-1
100. Rajkumari S, Sanatombi K. Nutritional value, phytochemical composition, and biological activities of edible Curcuma species: A review. *International* Journal of Food Properties. 2017; 20(sup3):S2668-S2687.
101. Chandrasekaran CV, Sundarajan K, Edwin JR, Gururaja GM, Mundkinajeddu D, Agarwal A. Immune-stimulatory and anti-inflammatory activities of Curcuma longa extract and its polysaccharide fraction. *Pharmacognosy Research.* 2013; 5(2):71–79. https://doi.org/10.4103/0974-8490.110527
102. Abdel-Lateef E, Mahmoud F, Hammam O, El-Ahwany E, El-Wakil E, Kandil S, et al. Bioactive chemical constituents of Curcuma longa L. rhizomes extract inhibit the growth of human hepatoma cell line (HepG2). *Acta Pharmaceutica.* 2016; 66(3):387-398
103. Liu Y, Nair MG. Curcuma longa and Curcuma mangga leaves exhibit functional food property. *Food Chemistry.* 2012; 135(2):634-640.
104. Khajehdehi P. Turmeric: Reemerging of a neglected Asian traditional remedy. *Journal of Nephropathology.* 2012; 1(1):17.
105. Mounce B, Cesaro T, Carrau L, Vallet T, Vignuzzi M. Curcumin inhibits zika and chikungunya virus infection by inhibiting cell binding. *Antiviral Research.* 2017; 142:148-157. doi:10.1016/j.antiviral.2017.03.014
106. Zorofchian Moghadamtousi S, Abdul Kadir H, Hassandarvish P, Tajik H, Abubakar S, Zandi K. A review on antibacterial, antiviral, and antifungal activity of curcumin. *BioMed Research International.* 2014; 186864-12. doi:10.1155/2014/186864
107. Josling P. Preventing the common cold with a garlic supplement: A double-blind, placebo-controlled survey. *Advances in Therapy.* 2001; 18(4):189-193.
108. Ban JO, Oh JH, Kim TM, Kim DJ, Jeong HS, Han SB, Hong JT. Anti-inflammatory and arthritic effects of thiochromones, a novel sulfurcompound isolated from garlic via inhibition of NF-κB. *Arthritis Research & Therapy.* 2009; 11(5):R145.
109. Keophiphath M, Priem F, Jacquemond-Collet I, Clément K, Lacasa D. 1, 2-vinyldithiin from garlic inhibits differentiation and inflammation of human preadipocytes. *The Journal of Nutrition.* 2009; 139(11):2055-2060.
110. Basu A. Spices in meals: A novel approach to cool down inflammation. *The Journal of Nutrition.* 2020; nxaa099. https://doi.org/10.1093/jn/nxaa099
111. Srinivasan K. Anti-cholelithogenic potential of dietary spices and their bioactives. *Critical Reviews In Food Science And Nutrition.* 2017; 57(8):1749-1758.
112. Park C, Moon DO, Choi IW, Choi BT, Nam TJ, Rhu CH, et al. Curcumin induces apoptosis and inhibits prostaglandin E2 production in synovial fibroblasts of patients with rheumatoid arthritis. *International Journal of Molecular Medicine.* 2007; 20(3):365-372.
113. Anderson CA, Cobb LK, Miller III ER, Woodward M, Hottenstein A, Chang AR, et al. Effects of a behavioral intervention that emphasizes spices and herbs on adherence to recommended sodium intake: Results of the SPICE randomized clinical trial. *The American Journal of Clinical Nutrition.* 2015; 102(3):671-679.
114. Sacks FM, Svetkey LP, Vollmer WM, Appel LJ, Bray GA, Harsha D, et al. Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. *New England Journal of Medicine.* 2001; 344(1):3-10.
115. Visioli F, Borsani L, Galli C. Diet and prevention of coronary heart disease: The potential role of phytochemicals. *Cardiovascular Research.* 2000; 47(3):419-425. https://doi.org/10.1016/S0008-6363(00)00053-5
116. Gardener H, Rundek T, Wright CB, Elkind MS, Sacco RL. Dietary sodium and risk of stroke in the Northern Manhattan study. *Stroke.* 2012; 43(5):1200-1205. https://doi.org/10.1161/STROKEAHA.111.641043
117. Shin H, Choi M, Ryu B, Lee N, Kim H, Choi H, et al. Antiviral activity of carnosic acid against respiratory syncytial virus. *Virology Journal.* 2013; 10(1):303-303. doi:10.1186/1743-422X-10-303
118. El-Awady SI, Essam T, Hashem A, Boseila AA, Mohmmed AF. Assessment of antiviral activity for Lamiaceae family members against RNA and DNA virus models using cell-culture: in vitro study. *World Journal of Medical Sciences.* 2014; 11(1):111-119.
119. Shetty K. Biotechnology to harness the benefits of dietary phenolics; Focus on Lamiaceae. *Asia Pacific Journal of Clinical Nutrition.* 1997; 6:162-171.
120. Chohan M, Naughton DP, Opara EI. Determination of superoxide dismutase mimetic activity in common culinary herbs. *SpringerPlus.* 2014; 3(1):578.
121. Santoyo S, Jaime L, García-Risco MR, Ruíz-Rodríguez A, Reglero G. Antiviral properties of supercritical CO2 extracts from oregano and sage. *International Journal of Food Properties.* 2014; 17(5):1150-1161.
122. Meneses R, Ocazionez RE, Martínez JR, Stashenko EE. Inhibitory effect of essential oils obtained from plants grown in Colombia on yellow fever virus replication in vitro. *Annals of Clinical Microbiology and Antimicrobials.* 2009; 8(1):8.
123. Gilling DH, Kitajima M, Torrey JR, Bright KR. Antiviral efficacy and mechanisms of action of oregano essential oil and its primary component carvacrol against murine norovirus. *Journal of Applied Microbiology.* 2014; 116(5):1149-1163.
124. Chun SS, Vattem DA, Lin YT, Shetty K. Phenolic antioxidants from clonal oregano (Origanum vulgare) with antimicrobial activity against Helicobacter pylori. *Process Biochemistry.* 2005; 40(2):809-816.

125. Pathak Nimish L, Kasture Sanjay B, Bhatt Nayna M, Rathod Jaimik D. Phytopharmacological properties of Coriander sativum as a potential medicinal tree: An overview. *J Appl Pharm Sci.* 2011; 1(4):20-5.
126. Martins N, Barros L, Santos-Buelga C, Ferreira IC. Antioxidant potential of two Apiaceae plant extracts: A comparative study focused on the phenolic composition. *Industrial Crops and Products.* 2016; 79:188-194.
127. Nadeem M, Anjum FM, Khan MI, Tehseen S, El-Ghorab A, Sultan JI. Nutritional and medicinal aspects of coriander (Coriandrum sativum L.). *British Food Journal.* 2013; 115(5):734-755.
128. Wang YJ, Pan KL, Hsieh TC, Chang TY, Lin WH, Hsu JTA. Diosgenin, a plant-derived sapogenin, exhibits antiviral activity in vitro against hepatitis C virus. *Journal of Natural Products.* 2011; 74(4):580-584.
129. Smith M. Therapeutic applications of fenugreek. *Alternative Medicine Review.* 2003; 8(1):20-27.
130. Yadav UCS, Baquer NZ. Pharmacological effects of trigonella foenum-graecum L in health and disease. *Pharmaceutical Biology.* 2014; 52(2):243-254. doi:10.3109/13880209.2013.826247
131. Goyal S, Gupta N, Chatterjee S. Investigating therapeutic potential of trigonella foenum-graecum L as our defense mechanism against several human diseases. *Journal of Toxicology.* 2016.1250387.doi:10.1155/2016/1250387
132. Kenny O, Smyth TJ, Hewage CM, Brunton NP. Antioxidant properties and quantitative UPLC-MS analysis of phenolic compounds from extracts of fenugreek (Trigonella foenum-graecum) seeds and bitter melon (Momordica charantia) fruit. *Food Chemistry.* 2013; 141(4):4295-4302.
133. Randhawa MA, Alghamdi MS. Anticancer activity of Nigella sativa (black seed) - A review. *The American Journal of Chinese Medicine.* 2011; 39(06):1075-1091.
134. Hassanien MFR, Assiri AMA, Alzohairy AM, Oraby HF. Health-promoting value and food applications of black cumin essential oil: An overview. *Journal of Food Science and Technology.* 2015; 52(10):6136-6142. doi:10.1007/s13197-015-1785-4
135. Singh S, Das SS, Singh G, Schuff C, de Lampasona MP, Catalán CAN. Composition, in vitro antioxidant and antimicrobial activities of essential oil and oleoresins obtained from black cumin seeds (nigella sativa L). *BioMed Research International.* 2014; 1-10. doi:10.1155/2014/918209
136. Bourgou S, Pichette A, Marzouk B, Legault J. Bioactivities of black cumin essential oil and its main terpenes from Tunisia. *South African Journal of Botany.* 2010; 76(2):210-216. doi:10.1016/j.sajb.2009.10.009
137. Sun T, Xu Z, Wu C-T, Janes M, Prinyawiwatkul W, No HK. Antioxidant activities of different colored sweet bell peppers (Capsicum annuum L.). *Journal of Food Science.* 2007; 72:S98-S102. doi:10.1111/j.1750-3841.2006.00245.x
138. Khan FA, Mahmood T, Ali M, Saeed A, Maalik A. Pharmacological importance of an ethnobotanical plant: Capsicum annuum L. *Natural Product Research.* 2014; 28(16):1267-1274.
139. Bourne N, Bernstein DI, Stanberry LR. Civamide (cis-capsaicin) for treatment of primary or recurrent experimental genital herpes. *Antimicrobial Agents and Chemotherapy.* 1999; 43(11):2685-2688.
140. Spiller F, Alves MK, Vieira SM, Carvalho TA, Leite CE, Lunardelli A, et al. Anti-inflammatory effects of red pepper (Capsicum baccatum) on carrageenan-and antigen-induced inflammation. *Journal of Pharmacy and Pharmacology.* 2008; 60(4):473-478.
141. Beltran J, Ghosh AK, Basu S. Immunotherapy of tumors with neuroimmune ligand capsaicin. *The Journal of Immunology.* 2007; 178(5):3260-3264.
142. Takano F, Yamaguchi M, Takada S, Shoda S, Yahagi N, Takahashi T, Ohta T. Capsicum ethanol extracts and capsaicin enhance interleukin-2 and interferon-gamma production in cultured murine Peyer's patch cells ex vivo. *Life Sciences.* 2007; 80(17):1553-1563.
143. Parvez GM. Current advances in pharmacological activity and toxic effects of various capsicum species. *Int. J. Pharm. Sci. Res.* 2017; 8:1900-1912.
144. Meghwal M, Goswami TK. Nutritional constituent of black pepper as medicinal molecules: A review. *Open Access Scientific Reports.* 2012; 1(1):1-7. doi:10.4172/scientificreports.129
145. Meghwal M, Goswami TK. Piper nigrum and piperine: An update. *Phytotherapy Research : PTR.* 2013; 27(8):1121–1130. https://doi.org/10.1002/ptr.4972
146. Ahmad N, Fazal H, Abbasi BH, Farooq S, Ali M, Khan MA. Biological role of Piper nigrum L. (Black pepper): A review. *Asian Pacific Journal of Tropical Biomedicine.* 2012; 2(3):S1945-S1953.
147. Kapoor IPS, Singh B, Singh G, De Heluani CS, De Lampasona MP, Catalan CA. Chemistry and in vitro antioxidant activity of volatile oil and oleoresins of black pepper (Piper nigrum). *Journal of Agricultural and Food Chemistry.* 2009; 57(12):5358-5364.
148. Srinivasan K. Black pepper and its pungent principle-piperine: A review of diverse physiological effects. *Critical Reviews in Food Science and Nutrition.* 2007; 47(8):735–748. https://doi.org/10.1080/10408390601062054
149. Borek C. Antioxidant health effects of aged garlic extract. *The Journal of Nutrition.* 2001; 131(3):1010S-1015S.
150. Butt M, Sultan M, Iqbal J, Butt M, Sultan M, Butt M, Iqbal J. Garlic: Nature's protection against physiological threats. *Critical Reviews in Food Science and Nutrition.* 2009; 49(6):538–551. https://doi.org/10.1080/10408390802145344
151. Bayan L, Koulivand PH, Gorji A. Garlic: A review of potential therapeutic effects. *Avicenna Journal of Phytomedicine.* 2014; 4(1):1.
152. Ryu JH, Kang D. Physicochemical properties, biological activity, health benefits, and general limitations of aged black garlic: A review. *Molecules.* 2017; 22(6):919.
153. Sultana MR, Bagul PK, Katare PB, Mohammed SA, Padiya R, Banerjee SK. Garlic activates SIRT-3 to prevent cardiac oxidative stress and mitochondrial dysfunction in diabetes. *Life Sciences.* 2016; 164:42-51.
154. Bjarnsholt T, Jensen PØ, Rasmussen TB, Christophersen L, Calum H, Hentzer M, et al. Garlic blocks quorum sensing and promotes rapid clearing of pulmonary Pseudomonas aeruginosa infections. *Microbiology.* 2005; 151(12):3873-3880.
155. Santas J, Almajano MP, Carbó R. Antimicrobial and antioxidant activity of crude onion (Allium cepa, L) extracts. *International Journal of Food Science & Technology.* 2010; 45(2):403-409.
156. Shim S-M, Yi H-L, Kim Y-S. Bioaccessibility of flavonoids and total phenolic content in onions and its relationship with antioxidant activity. International Journal of Food Sciences and Nutrition. 2011; 62(8):835–838.
157. Dreosti IE. Bioactive ingredients: Antioxidants and polyphenols in tea. *Nutrition Reviews.* 1996; 54(11):S51-S58.
158. Xu J, Xu Z, Zheng W. A Review of the antiviral role of green tea catechins. *Molecules.* 2017; 22(8):1337. https://doi.org/10.3390/molecules22081337
159. Furushima D, Ide K, Yamada H. Effect of tea catechins on influenza infection and the common cold with a focus on epidemiological/clinical studies. *Molecules.* 2018; 23(7):1795. https://doi.org/10.3390/molecules23071795
160. Joubert E, Ferreira D. Antioxidants of Rooibos tea-a possible explanation for its health promoting properties?. *SA Journal of Food Science and Nutrition.* 1996; 8:79-84.
161. Ravikumar C. Review on herbal teas. *Journal of Pharmaceutical Sciences and Research.* 2014; 6(5):236.
162. Senanayake SN. Green tea extract: Chemistry, antioxidant properties and food applications–A review. *Journal of Functional Foods.* 2013; 5(4):1529-1541.
163. Ide K, Kawasaki Y, Kawakami K, Yamada H. Anti-influenza virus effects of catechins: A molecular and clinical review. *Current Medicinal Chemistry.* 2016; 23(42):4773-4783. https://doi.org/10.2174/0929867324666161123091010
164. Khan N, Mukhtar H. Tea polyphenols in promotion of human health. *Nutrients.* 2018; 11(1):39. https://doi.org/10.3390/nu11010039
165. Peter K V (ed.). Handbook of herbs and spices. Woodhead Publishing Limited, Elsevier, 2012. Accessed May 20, 2020, from https://www.academia.edu/18671222/Handbook_of_Herbs_and_Spices_Vol_2
166. Kaefer CM, Milner JA. The role of herbs and spices in cancer prevention. The *Journal of Nutritional Biochemistry.* 2008; 19(6):347-361.
167. Shahidi F, Ambigaipalan P. Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects: A review. *Journal of Functional Foods.* 2015; 18: 820-897.
168. Kaefer CM, Milner JA. 17 Herbs and spices in cancer prevention and treatment. *Lester Packer.* 2011; 361.
169. Yashin A, Yashin Y, Xia X, Nemzer B. Antioxidant activity of spices and their impact on human health: A review. *Antioxidants.* 2017; 6(3):70.
170. Shan B, Cai YZ, Sun M, Corke H. Antioxidant capacity of 26 spice extracts and characterization of their phenolic constituents. *Journal of Agricultural and Food Chemistry.* 2005; 53(20):7749-7759.
171. Lampe J. Spicing up a vegetarian diet: Chemopreventive effects of phytochemicals. *American Journal of Clinical Nutrition.* 2003; 78(3):579S-583S. doi:10.1093/ajcn/78.3.579S
172. Jassim SAA, Naji MA. Novel antiviral agents: A medicinal plant perspective. *Journal of Applied Microbiology.* 2003; 95(3):412-427. doi:10.1046/j.1365-2672.2003.02026.x
173. Bi X, Lim J, Jeyakumar Henry C. Spices in the management of diabetes mellitus. *Food Chem.* Elsevier; 2017; 217:281–293. doi: 10.1016/j.foodchem.2016.08.111
174. Shalaby MA, Saifan HY. Some pharmacological effects of cinnamon and ginger herbs in obese diabetic rats. *Journal of Intercultural Ethnopharmacology.* 2014; 3(4):144.
175. World Health Organization. Coronavirus disease (COVID-19) advice for the public. April 29, 2020. Accessed May 20, 2020, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public
176. Maizes V, Rakel D, Niemiec C. Integrative medicine and patient-centered care. *Explore.* 2009; 5(5):277-289.
177. Vellingiri B, Jayaramayya K, Iyer M, Narayanasamy A, Govindasamy V, Giridharan B, et al. COVID-19: A promising cure for the global panic. *Science of the Total Environment.* 2020; 138277.
178. Das S, Sarmah S, Lyndem S. An investigation into the identification of potential inhibitors of SARS-CoV-2 main protease using molecular docking study. *Journal of Biomolecular Structure & Dynamics.* 2020; 1-11. https://doi.org/10.1080/07391102.2020.1763201
179. Jo S, Kim H, Kim S, Shin DH, Kim MS. Characteristics of flavonoids as potent MERS-CoV 3C-like protease inhibitors. *Chemical Biology & Drug Design.* 2019; 94(6):2023–2030. https://doi.org/10.1111/cbdd.13604

180. Jo S, Kim S, Shin DH, Kim MS. Inhibition of SARS-CoV 3CL protease by flavonoids. *Journal of Enzyme Inhibition And Medicinal Chemistry.* 2020; 35(1):145-151. https://doi.org/10.1080/14756366.2019.1690480
181. Kundu D, Selvaraj C, Singh SK, Dubey VK. Identification of new anti-nCoV drug chemical compounds from Indian spices exploiting SARS-CoV-2 main protease as target. *Journal of Biomolecular Structure & Dynamics.* 2020; 1-9. doi: 10.1080/07391102.2020.1763202
182. Kim DE, Min JS, Jang MS, Lee JY, Shin YS, Park CM, et al. Natural bis-benzylisoquinoline alkaloids-tetrandrine, fangchinoline, and cepharanthine, inhibit human coronavirus OC43 infection of MRC-5 human lung cells. *Biomolecules.* 2019; 9(11):696.
183. Yang Y, Islam MS, Wang J, Li Y, Chen X. Traditional Chinese Medicine in the treatment of patients infected with 2019 - new coronavirus (SARS-CoV-2): A review and perspective. *International Journal of Biological Sciences.* 2020; 16(10):1708–1717. https://doi.org/10.7150/ijbs.45538
184. Islam MT, Sarkar C, El-Kersh DM, Jamaddar S, Uddin SJ, Shilpi JA, Mubarak MS. Natural products and their derivatives against coronavirus: A review of the non-clinical and pre-clinical data. *Phytotherapy Research.* 2020; 1-22.
185. Wink M. Potential of DNA intercalating alkaloids and other plant secondary metabolites against SARS-CoV-2 causing COVID-19. *Diversity.* 2020; 12(5):175.
186. Prasher P, Sharma M, Mehta M, Paudel KR, Satija S, Chellappan DK, et al. Plants derived therapeutic strategies targeting chronic respiratory diseases: Chemical and immunological perspective. *Chemico-Biological Interactions.* 2020; 109125.