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Nutraceutical properties of recommended horticultural crops to develop human immune system against COVID-19

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Abstract
Scientific reports state that horticultural crops namely fruits, vegetables, spices and medicinal plants play an important role in treating several diseases. They are useful in curing nutrient deficiency diseases. There are several examples available in Ayurvedic literature about the role of different horticultural crops in human diet. Viral infections play an important role in human diseases, and recent outbreaks in the advent of globalization and ease of travel have underscored their prevention as a critical issue in safeguarding public health. The dietary management should be considered in terms of improving immunity and utilizing the anti-viral properties of few nutrients. Eating a low-fat, plant-based vegetarian diet may boost the immune system. Vegetarians have been shown in a few studies to have more effective white blood cells compared to non-vegetarians, because of a higher intake of vitamins and lower intake of fat. This review deals with major recommended horticultural crops in India to immune system against viral diseases particularly, COVID19.

Keywords: Nutraceuticals, anti-viral property, anti-oxidant, immunity, horticulture

Introduction
Viral infections play an important role in human diseases, and recent outbreaks in the advent of globalization and ease of travel have underscored their prevention as a critical issue in safeguarding public health. Though the medical sector reaches its golden time, many viruses lack preventive vaccines and efficient antiviral therapies, which are often beset by the generation of viral escape mutants. Due to increased global travel and rapid urbanization, epidemic outbreaks caused by emerging and re-emerging viruses represent a critical threat to public health, particularly when preventive vaccines and antiviral therapies are unavailable. Outbreak of dengue virus, influenza virus, measles virus, severe acute respiratory syndrome (SARS) virus, West Nile virus and COVID 19 are some of the facts we seen globally cause lethal to human beings. COVID'19 started as an acute viral respiratory illness in Wuhan state of china at the far end of 2019. It spread as a pandemic to all the countries infecting lakhs of people killing many thousands globally. In this deficient scientific evidence to control the pandemic, nutrition and diet should be supplemented to these patients. The dietary management should be considered in terms of improving immunity and utilizing the anti-viral properties of few nutrients. Eating a low-fat, plant-based vegetarian diet may boost the immune system. Vegetarians have been shown in a few studies to have more effective white blood cells compared to non-vegetarians, because of a higher intake of vitamins and lower intake of fat.

Scientific reports state that horticultural crops namely fruits, vegetables, spices and medicinal plants play an important role in treating several diseases. They are useful in curing nutrient deficiency diseases. There are several examples available in Ayurvedic literature about the role of different horticultural crops in human diet. They are the food products supplemented with herbal ingredients, vitamins, minerals and nutrients. They are now popularly known as "Nutraceuticals', the word first coined in 1996 by Stephen De Felice. These are defined as parts of a food or a whole food that have a medicinal or health benefit including prevention and treatment of disease. These are bridge the gap between food and medicines. Besides basic nutritional value, they provide health and medicinal benefits.

This review deals with major recommended horticultural crops in India to immune system against viral diseases particularly, COVID19.

Aonla

Aonla or Amla (*Emblica officinalis*). It is also called as 'Goose berry, The Ayurvedic wonder'. The fruit of amla have enormous medicinal values. Fruits are highly nutritious as it contains carbohydrates, fiber and minerals like calcium, prosperous, iron, vitamin C and vitamin B complex (Yallesh Kumar *et al.*, 2018) [69]. Medicinal properties: Antiscorbutic (cures scurvy), diuretic, laxative, antibiotic and anti-dysenteric. The fruits contain proteins, ascorbic acid and higher concentrations of most minerals and amino acids. Glutamic acid, proline, aspartic acid, alanine and lysine are the important amino acids present in amla fruits. It is profusely used in the process of complete rejuvenation of the body. It prevents grey hair, hair falling, is anti-aging, and purifies blood. It is very useful in constipation. It has recorded evidences of increasing eyesight and aphrodisiac effects. It also helps in digestion of food. It is astringent in taste and cause cooling effect on the body. The fruit is acrid, cooling refrigerant, diuretic and laxative. The dried fruit is useful in hemorrhage, diarrhea and dysentery. They are anabolic, anti bacterial and resistance building. They possess expectorant, cardio tonic, anti-pyretic, anti oxidative, antiviral and anti emetic activities. They are also used in the treatment of leucorrhoea and artheroschlerosis. It is highly useful in treating respiratory problems like, asthma, bronchitis, tuberculosis, etc. It is very useful in diabetes, skin diseases, diarrhea, piles, pain, white discharges, bleeding disorders, kidney problem and cataract. It is the main ingredient of the ayurvedic preparation 'Chyavanprasha' and one of the three ingredients of 'Thiphala choorna', (mixture of Amla, *Terminalia chebula* and *T. bellerica) Brahma Rasayana* and *Madumegha churna* which is a health and digestion tonic, which also prevents hair from premature graying and falling. Even amla flowers have laxative properties. Amla juice along with bitter gourd juice taken daily stimulates the pancreas to produce more insulin. Similarly, a mixture of amla powder, jamun seed powder and bitter gourd powder taken daily for best results. Dried amla mixed with jaggery is a very effective cure for rheumatism. Phylloemblin, obtained from fruit pulp has been found to have mild depressant action on central nervous system and good liver tonic (Farooqi, 2015) [20]. Water in which dried amla is soaked makes a soothing lotion for eyes, while amla juice with honey is useful in preserving eye sight, curring glaucoma and conjunctivitis. Regular dose of the juice improves eyesight and good for eye muscles. (Hegade, 2005) [27]. Recent study reported that aonla extracts have anti-fungal, anti-bacterial (Sidhu *et al*. 2007) [58] and antiviral properties (Balasubramaniam *et al.*, 2007) [8].

Mango

Mangoes belong to genus *Mangifera* which consists of about 30 species of tropical fruiting trees in the flowering plant family Anacardiaceae. *Mangifera indica*, is native tropical Asia and has been cultivated in the Indian subcontinent for over 4000 years and is now found naturalized in most tropical countries (Shah *et al.*, 2010) [54]. Mangiferin, being a polyphenolic antioxidant and a glucosyl xanthone, it has strong antioxidant, anti lipid peroxidation, immunomodulation, cardiotonic, hypotensive, wound healing, antidegenerative and antidiabetic activities. Mango, used in Ayurvedic and indigenous medical systems for over 4000 years (Shah *et al.*, 2010) [54].

Mango is a valuable fruit from a nutritional point of view, providing fiber, micronutrients as carbohydrates (10–32% in ripe pulp), proteins (0–5%), amino acids (alanine, arginine, glycine, serine, leucine, and isoleucine), lipids (0.75% to 1.7%), and organic acids (citric is the major organic acid, 0.13% to 0.71% FW). Mango fruit also provides macronutrients such as vitamins (vitamin C, from 9.79 to 186 mg/100 g of mango pulp; vitamin A, from 1,000 to 6,000 IU; E and K vitamins are found in minor quantities; D vitamin has not been detected in any cultivars until now). Except for biotin, all the other B vitamins have been found in mango fruit. In addition, mango fruit is an important source of polyphenols (catechins, quercetin, kaempferol, rhamnetin, anthocyanins, tannic acid, and mangiferin; carotenoids, organic acids, and volatile compounds), useful for medicinal applications and also as indicators of fruit quality. All these concentrations depend on ripe state of the mango pulp and peel (Maldonado *et al.*, 2019) [40]. Hu *et al.*, (2018) [30] recently identified tentatively 34 compounds as derivatives of phenolic acids including gallotannins and quercetin derivatives, reporting for first time the detection of rosmarinic acid in mango fruit in different stages of ripeness, both in the peel and in the pulp.In the pulp of mango, the major flavonols are glycosides of quercetin (glucose, galactose, rhamnose, xylose, and arabinose), whereas kaempferol, isorhamnetin, fisetin, and myricetin are present in minor levels (Ramirez *et al.*, 2013; USDA, 2018) [50, 65]. Mangiferin can be obtained from the bark, fruits, roots, and leaves of *Mangifera indica* Linn (Matheyambath *et al.*, 2016). It has also described that mangiferin is able to activate anticancer, antimicrobial, antiatherosclerotic, antiallergenic, anti-inflammatory, analgesic, and immunomodulatory activities (Berardini *et al*., 2003; Ribeiro *et al*., 2008; Saleem-Dar *et al*., 2016; Ediriweera *et al*., 2017; Imran *et al*., 2017). *In vitro* the effect of mangiferin was studied against *Herpes simplex* virus type 2; mangiferin does not directly inactivate HSV-2 but inhibits the late event in HSV-2 replication (Zhu *et al*., 1993) [73]. *In vitro* mangiferin was also able to inhibit HSV-1 virus replication within cells (Zheng *et al*., 1990) [72] and to antagonize the cytopathic effects of HIV (Guha *et al*., 1996) [23]. Mango fruit is rich in carotenoid compounds. These molecules are lipid-soluble stains contributing to yellow-orange colors of mango fruit and red colors when mango is ripe, although the reddish color of peel in several varieties is due to anthocyanins (Sivankalyani *et al*., 2016) [60]. These compounds are classified in carotenes (α-carotene, β-carotene and γ-carotene), and xanthophylls (auroxanthin, antheraxanthin, neoxanthin, lutein, violaxanthin, and zeaxanthin) (Varakumar *et al*., 2011; Eskin and Hoehn, 2013) [66, 19].

Banana

Banana (Musa) is one of the major fruit which is produced in nation in terms of both production and area coverage (CSA, 2004) [16] where the bulk is produced in traditional agricultural system. Banana is a healthy and moderately well balanced origin of nutrient rich several carohydrates, vitamins and mineral salts with a low amount of protein and oil (Ahenkora *et al.*, 1997) [1]. They are eaten as raw as well as desert fruits. Agricultural industries and public agencies increasingly use nutritional information to upgrade fresh products. Consumers are apprised of the health advantages of fresh vegetables and fruits and looking for variation in the diets. They are rich in

anti-oxidant vitamins (Vitamin C, Vitamin A, and Vitamin E), calcium, magnesium and potassium (Marisa, 2006) [42]. They are considered as nutritional with a high amount of vitamin A and vitamin C content but is low in vitamins B. Generally, they contain an appreciable content of mineral and therefore can be used as mineral supplement in diets. Jouneghani *et al.*, (2020) [32] tested selected banana cultivars for their antiviral but also cytotoxic properties. Di_erent parts such as leaf, pseudostem and corm, collected separately and extracted with four different solvents (hexane, acetone, ethanol, and water), were tested for *in vitro* antiviral activity against Chikungunya virus (CHIKV), enterovirus 71 (EV71), and yellow fever virus (YFV). The results demonstrate that the genetically closely-related banana cultivars with genome ABB such as Namwa Khom, Pelipita, Fougamou and Kluai Tiparot are poetical sources for developing antiviral drugs CHIKV, while Namwa Khom and Fougamou cultivars can provide antiviral compounds against YFV

Papaya

Papaya is a tasty and juicy fruit belonging to the Caricaceae family scientifically known as (*Carica papaya* L.) and is cultivated in all the tropical and sub-tropical states of world. Papaya is a rich source of vitamin C and vitamin B. Its mineral composition consists of K and Mg with calcium, iron, manganese, phosphorus, zinc etc. (Hardisson *et al.*, 2004) [25]. It also has a digestive enzyme papain that helps in preventing allergies, sports injuries and trauma. It also exhibit a significant role in the protein digestion present in food at alkaline, neutral and acidic medium and hence can be advised for the dyspeptic patients, who has the difficulty in digesting wheat protein gliandin but can indulge it if it is dealed with the crude papain. Papaya as a whole, enhance cardiovascular system, provide protection from heart attacks, colon cancer and strokes. This fruit is a very rich source of beta-carotene that stops damage produced by free radicals which can be the cause of cancer. It was announced that it also helped out in the stoppage of diabetic diseases. The brewed papaya is also a good neutraceutical as the antioxidant. It enhances the antioxidant protection in old patients although in the absence of any antioxidant inadequacy state at the dosage of 9 g per day orally (Marotta *et al.*, 2006) [43]. Papaya as a healthful fruit is also used in desert; ripened fruit is eaten as salad and unripe is cooked as a vegetable. It is purgative, stimulates production of bile and digestion which makes our liver and pancreas healthy (Aravind *et al.*, 2013) [6]. As it is rich in fibre it helps in lowering high cholesterol level. It also has been incorporated in commercial preparation such as meat tenderizer, stabilizer and as chew-gums and to clarify the beer. Though some work on utilization of papaya in preparation of valuable products such as beverages, jam, jelly etc. has been reported in the literature but negligible work on development of toffee and leather has far been reported. The methanolic produced from immature (*C. papaya*) was assessed *in vivo* to know that what are its effects on the activities of few antioxidant enzymes that includes glutathione peroxidase, glutathione transferase, glucose-6-phosphate dehydrogenase, glutathione reductase and catalase in mice which was treated with an orally dosage of 100 mg/kg. Due to the presence of ethyl acetate fraction, there was a remarkable increment in activities of glutathione reductase, GPx, GST and glucose-6-phosphate dehydrogenase. A remarkable decrement in GPx was noticed in kidney due to the presence of ethyl acetate fraction. It was proposed that βsitosterol and quercetin can be the reason behind the antioxidant potential (Oloyede OI, 2005) [47]. The aqueous produced from (C. papaya) roots and leaves at various combinations (25, 50, 100, 200 mg/mL) perceived antimicrobial activity for few human pathogenic bacteria by using agar diffusion method (Anibijuwn II and Udeze, 2009) [3]. The (*C. papaya*) latex and fluconazole possess synergistic action to inhibit the growth of the Candida albicans which results in partial degradation of cell wall. Latex proteins proved to have minimum concentration of protein and antifungal action to produces a complete inhibition (Giordani *et al.*, 1991) [21].

Citrus

Citrus fruits and juices contain a wide range of substances including carbohydrates, fibre, vitamin C, potassium, folate, calcium, thiamine, niacin, vitamin B6, vitamin A, phosphorus, magnesium, copper, riboflavin, pantothenic acid and a variety of phytochemicals. These substances are necessary for proper functioning of the body but some confer additional protection against chronic disease over and basic nutrition. Citrus fruits also contained many phytochemicals including essential oils, alkaloids, flavonoids, coumarins, psoralens and carotenoids. The previous pharmacological studies revealed that citrus fruits possessed antimicrobial, anthelmintic, insect repellent, antioxidant, anticancer, cardiovascular, central nervous, anti-inflammatory, analgesic, antidiabetic, reproductive, gastrointestinal, immunological, respiratory and many other pharmacological effects. Al-Aamri *et al.*, (2018) [77] reported that the antimicrobial activity of acidlime is primarily due to their complex chemical composition, including substances belonging to a broad range of chemical classes including terpenes, aldehydes, alcohols, esters, phenols, ethers, and ketones. A GC–MS analysis of lime leaf essential oil detected 33 volatile chemical compounds, three of which remain unidentified (9.1%). D-limonene was found to be the major constituent, confirming the limonene chemotype of the Al-Sharqia lime variety. The lime leaves oil demonstrated concentration-dependent inhibition of DPPH radicals with an IC_{50} value of 21.87 µg/mL. Its *in-vitro* free radical scavenging activity was nearly comparable to that of ascorbic acid at a concentration of 50 µg/mL. On the other hand, the oil had moderate anti-bacterial activities. Further, more detailed studies are recommended to explore the potential of *C. aurantifolia* leaves essential oil as a food preservative and a source of natural antioxidants.

Carrot

Carrot is a taproot which is rich in beta-carotene. Liu *et al.*, 2010 [38], found that in a cell culture system, β-carotene could decrease the hepatosteatosis induced by the hepatitis C virus (HCV) by inhibiting RNA replication. Through its activity of provitamin A and its role in the inhibition of reactive oxygen species, β-carotene has been confirmed to have a positive effect on the progression of the hepatitis virus (HBV and HCV), preventing the development of carcinoma hepatocellular (Yadav *et al.*, 2002) [68]. Beta-carotene is a powerful antioxidant that can reduce inflammation and boost immune function by increasing leucocytes in the body. Lin *et al.*, 2012 [37] described the anti-inflammatory effect of beta-carotene and its potential use as anti-inflammatory agent for DNA virus infection. Liu *et al.*, 2010 [38], found that in a cell culture system, β-carotene could decrease the hepatosteatosis induced by the hepatitis C virus (HCV) by inhibiting RNA replication. Through its activity of provitamin A and its role in the inhibition of reactive oxygen species, β-carotene has

been confirmed to have a positive effect on the progression of the hepatitis virus (HBV and HCV), preventing the development of carcinoma hepatocellular (Yadav *et al*., 2002) [68]. Beta-carotene is a powerful antioxidant that can reduce inflammation and boost immune function by increasing leucocytes in the body. Excellent sources of carotene derivatives include sweet potatoes, carrots, green leafy vegetables, pumpkin, summer squash, red and yellow bell peppers, peas, broccoli, paprika, chilli, tomato, parsley and coriander. U.S. Patent Application Publication No. 2007/0031356 and US2011/0082218 discloses UV mediated effect of beta-carotene on the expression of pro-inflammatory genes. Lin *et al.,* 2012 [37] described the anti-inflammatory effect of beta-carotene and its potential use as anti-inflammatory agent for DNA virus infection.

I.B.R. ISRAELI BIOTECHNOLOGY RESEARCH LTD. Patented a product (PCT No. WO 2017/029674 Al) whose compositions comprising carotenoids, particularly phytoene and phytofluene, useful in delaying viral infection in a subject and in methods of screening for anti- viral agents. German Patent Application Publication No. DE202005007462 discloses medicament or nutritional supplement composition, for combating chronic viral infections, containing vitamin C, vitamin E, coenzyme Q10, carotenoids, selenium, zinc and copper.

Black pepper

The dried unripe fruits of *Piper nigrum* L. (black pepper) are known in almost every cuisine worldwide and are often referred to as "king of spices". Moreover, *P. nigrum* is described to be endowed with health beneficial and disease preventing properties, like *e.g.* anti-inflammatory, antiviral, antipyretic, immune and bioavailability enhancing qualities (Meghwal and Goshwami, 2012) [44]. Black pepper contains terpenoids like alpha-pinene, sabinene, beta caryophyllene, delta-3-carene, limonene and beta pinene. In addition to these, it contains an alkaloid piperine also. These principles are known as nutritional medicines or nutraceuticals that give protection to our body from many diseases. Therefore these and related spices have medicinal potential and they form the common ingredients for the indigenous system of medicines in India, China and elsewhere (Augusti *et al.,* 2010) [7]

Turmeric

Turmeric have chemical compound is known to have antioxidant, antibacterial, antiviral, cardioprotective and immune stimulating properties. Though it is a famous spices all over the world, it is used in daily diet of Indian food preparations. The bioavailability of curcumin is increased by the addition of black pepper. In a study, researchers have found that the inflammatory cytokines like the mean serum IL-1β and the vascular endothelial growth factor were found to be significantly reduced by curcumin therapy. This assumes significance in the wake of corona epidemic where the cytokine surge is worsening patients rather than the virus replication (Hewlings and Kalman, 2017) [29].

Garlic

Allium sativum and *Allium cepa* have been recognized for their medicinal value since ancient time period. Both garlic and onion were reported to exhibit strong antiviral activity (Chen *et al.,* 2011) [12]. Both garlic and onion have a good amount of flavonols and organosulfur compounds which impart medicinal property to these plants. Garlic and Onion contains flavonoids such as anthocyanins and flavanols (Slimestad *et al.,* 2007) [61]. Isorhamnetin, Kaempferol Myricetin, and Quercetin are flavanols present in these plants (Anon, 2019). Onions (Sharma, 2019) [55] and garlic (Amagase, 2006) contain organosulfur compounds like quercetin and allicin which are associated with inhibition of viral infection. The amount of Quercetin is more as compared to other flavanols. Quercetin and kaempferol as main flavanols. These compounds have been found to affect the growth of many viruses (Kumar and Pandey, 2013) [35]. Quercetin, a main flavanol compound in onion and garlic, have been reported to inhibit the translation and replication of RNA of many human viruses Quercetin derivatives can increase zinc uptake, which can inhibit RNA Polymerase (Sreenivasulu *et al.,* 2010) [62]. It was proved that Polio-virus (Castrillo and Carrasco, 1987) [10], Rhinovirus (Hellen, *et al.,* 1989) [28], SARS-CoV (Chen *et al.,* 2006) [13], Hepatitis C virus (Gonzalez *et al.,* 2009) [22], Ebola virus (Qiu *et al.,* 2016) [49], Enterovirus (Yao *et al*., 2018) [70] were affected in the host cell by quercetin derivatives. These bioactive compounds can hinder virus attachment to the host cell. They can alter transcription and translation of viral genome inside the host cell and hence also affect the viral assembly. Inhibition of viral entry into the cell and inhibition of RNA polymerase have also been postulated as mechanism of antiviral actions of this vegetable. Flavanoids present in onion and garlic have a strong inhibitory effect on virus multiplication. Phytochemicals present in these plants have been observed to block the formation of protein and genetic material in the virus (Castrillo and Carrasco, 1987, Zandi *et al*., 2011) [10, 71].

Ginger

Ginger (*Zingiber officinale*) is a common and widely used spice. It is rich in various chemical constituents, including phenolic compounds, terpenes, polysaccharides, lipids, organic acids, and raw fibers. The health benefits of ginger are mainly attributed to its phenolic compounds, such as gingerols and shogaols. Accumulated investigations have demonstrated that ginger possesses multiple biological activities, including antioxidant, anti-inflammatory, antimicrobial, anticancer, neuroprotective, cardiovascular protective, respiratory protective, antiobesity, antidiabetic, antinausea, and antiemetic activities (Mao *et al.,* 2019) [41].

Chang *et al.,* (2013) [11] reported that fresh ginger has been proved to have antiviral activity against human respiratory syncytial virus (HRSV). Fresh ginger dose-dependently inhibited HRSV-induced plaque formation in both human upper (HEp-2) and low (A549) respiratory tract cell lines ($p<0.0001$). In contrast, dried ginger didn't show any dose-dependent inhibition. 300 µg/ml fresh ginger could decrease the plaque counts to 19.7% (A549) and 27.0% (HEp-2) of that of the control group. Fresh ginger was more effective when given before viral inoculation ($p<0.0001$), particularly on A549 cells. 300 µg/ml fresh ginger could decrease the plaque formation to 12.9% when given before viral inoculation. Fresh ginger dose-dependently inhibited viral attachment ($p<0.0001$) and internalization ($p<0.0001$). Fresh ginger of high concentration could stimulate mucosal cells to secrete IFN-β that possibly contributed to counteracting viral infection.

Tea

Tea (*Camellia sinensis*) is the most widely drunk beverage in the world. Green tea, popular in the Far East, differs from the black tea familiar in the West in that an oxidation step (called

''fermentation'') occurs in the processing of the latter compound but not the former compound. A series of well-conducted, systematic studies, mainly from Japan, now suggests that tea extracts show several useful antimicrobial effects. Toda *et al.* (1989) [64] found that extracts of tea inhibited and killed *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Salmonella typhi*, *Salmonella typhimurium*, *Salmonella enteritidis*, *Shigella flexneri*, *Shigella dysenteriae*, and *Vibrio* spp., including *Vibrio cholerae*. Tea extracts prevented rotavirus and enterovirus from infecting monkey kidney cells in tissue culture (Mukoyama *et al.*, 1991) [46]; this was ascribed to interference with viral adsorption rather than a direct antiviral effect. Preventive and curative effects of tea on influenza virus have been claimed in a patent (Shimamura abd Hara, 1991) [56]. Most interest has been shown in the polyphenolic compounds based on the isoflavan structure; these make up some 30% of the dry weight of flush (the growing point of the plant, consisting of the buds and immature leaves that are picked for processing) and black tea leaf. The simplest compounds in this class are the catechins; the larger molecules include theaflavins and thearubigins, which are oxidation and polymerization products of simple isoflavanoids. Theaflavins, found predominantly in black tea, contain a unique sevenmembered aromatic ring (tropolone). They combine with caffeine (3 to 4% of both flush and black tea) to form a substance known as ''cream,'' thereby modulating the bitterness and astringency of the individual compounds and giving tea its flavor. About 5% of the dry weight of black tea (10% in the case of green tea) and its aqueous extracts is made up of catechins, which are simple, well-characterized isoflavanoids (Hamilton-Miller, 1995) [24]. Leaf tea also contains small amounts of flavonols, such as quercitin, kaempferol, and myricetin (Kirk and Othmer, 1980) [74]. Plant polyphenols are generically known as ''tannins'' (Hawley, 1981) [26]. These are perceived in general as toxic compounds (Scalbert, 1991) [75], perhaps because of their ability to precipitate proteins. This property, called ''astringency'' in a chemical sense, was taken advantage of clinically in former times, when tannic acid ointment was used to treat superficial burns. Yang *et al.*, (2017) [37] reported that influenza poses a particular risk of severe outcomes in the elderly, the very young and those with underlying diseases. Tea polyphenols are the natural phenolic compounds in teas, and principally consist of catechins, proanthocyanidins, flavonols, and theaflavins, which antiviral activities have been reported recently. This study is to gain a further insight into potential of various tea polyphenols for inhibiting influenza virus infection. Five tea polyphenols exhibited inhibitory activity against influenza A virus in the trend of theaflavin > procyanidin B-2 > procyanidin B-2 digallate > (−)-epigallocatechin(EGC) > (−)-epigallocatechingallate(EGCG) with IC_{50} values in the range of 16.2–56.5 μg/ml. Six of the tested compounds showed anti-influenza B virus activity in the order of kaempferol > EGCG > procyanidin B-2 > (−)-EGC ~ methylated EGC > theaflavin with IC_{50} values in the range of 9.0–49.7 μg/ml. Based on these results, the structure–activity relationship (SAR) was explained as follows. First, the dimeric molecules, such as theaflavin and procyanidin B-2, generally displayed more potent antiviral activity against both influenza A and B viruses than the catechin monomers. Second, the kaempferol for inhibition of influenza B virus indicated that the more planar flavonol structure with only one C-4′ phenolic hydroxyl group in the B ring is necessary for the anti-influenza B virus activity. A similar SAR can be drawn from the assays of another enveloped RNA virus, such as respiratory syncytial virus. These results are expected to provide guides for rational design of antiviral drugs based on polyphenols.

Mint

It is the type species of the Japanese menthol plant mint (*Mentha arvensis* [MA] Linn. family Lamiaceae), a plant, native of Japan, is cultivated extensively in the temperate regions of Europe and western and central Asia, east to the Himalaya and eastern Siberia. The mint plant has been reported to possess terpenes such as α-menthol, neomenthol, isomenthol, d-menthone, isomenthone, menthofuran, menthylacetate, carvomenthone, cineol, p-cymene, aromadendrene, limonine, -phellandrene, pipertone, -pinene, carvacrol, α-pinene, α-phellandrene, -pinene, dipentene, cardinene, and -thujone in different proportions depending on the season, type of climate and the plant processing (Satyavati *et al*., 1987; Anon, 1972) [53, 5]. It also contains the flavonoids such as quercetin, menthoside, and isorhoifolin (Rastogi and Mehrotra, 1990) [51] vitamin K, thymol and eugenol (Satyavati *et al*., 1987) [53]. *Mentha arvensis*, a leafy spices used for culinary purposes. Besides its culinary uses, mint is also used in traditional systems of medicine for the treatment of biliary disorders, dyspepsia, enteritis, flatulence, gastritis, intestinal colic and for spasms of the bile duct, gallbladder and gastrointestinal tract. The major active ingredient of this plant, menthol and carvone, has been found to possess antioxidant, antimicrobial, anti-inflammatory and antitumor activities (Kunnumakkara *et al.*, 2009) [36].

Juice of leaves is given in diarrhea and dysentery. The leaves medicinally used for stomach problems and allergy. It is also used for the treatment of liver and spleen disease, asthma and jaundice. The infusion of these leaves is used in indigestion, rheumatic pains, arthritis, and as remedy for inflamed joints. Menthol derived from its essential oil is used in pharmaceutical, perfumery, and food industries. Menthol is antiseptic, carminative, refrigerant, stimulant and diuretic in properties and is used against skin infections (Thawkar *et al.*, 2016) [63]. By using disc diffusion assay, the antimicrobial activity of essential oil sample extracted from MA var. *piperacens* cultivated in Thailand was evaluated against zoonotic enteropathogens including *Salmonella* spp., *E. coli* O157, *Campylobacter jejuni*, and *Clostridium perfringens* which are important for broiler export. The essential oil of, MA var. *piperacens*, showed promising antibacterial activity against the bacteria tested (Wannissorn *et al.*, 2005) [67]. Menthol is virucidal against Influenza, Herpes and otherviruses *in vitro* (Eccles, 1994) [17]. Cineole, eugenol, and thymol, which are present in mint are reported to be a good antioxidant and inhibit lipid peroxidation (Santos and Rao, 2001). The flavonoids like quercetin, which is present in the mint have been reported to scavenge OH and superoxide free radicals and also inhibit the lipid peroxidation (Korkina and Afanas'ev, 1997) [34] The eugenol, terpenes, and flavonoids that are present in mint extract are good antioxidants and modulators of the xenobiotic enzymes, especially the Phase-2 enzymes like glutathione-s-transferase, and glutathione (Kong *et al*., 2000) [33]

Tulsi

Tulsi is an aromatic shrub in the basil family Lamiaceae (tribe ocimeae) that is thought to have originated in north central India and now grows native throughout the eastern world tropics (Bast *et al.*, 2014) [9] Within Ayurveda, tulsi is known

as "The Incomparable One," "Mother Medicine of Nature" and "The Queen of Herbs," and is revered as an "elixir of life" that is without equal for both its medicinal and spiritual properties (Singh *et al.,* 2010) [59]. Within India, tulsi has been adopted into spiritual rituals and lifestyle practices that provide a vast array of health benefits that are just beginning to be confirmed by modern science. Tulsi tastes hot and bitter and is said to penetrate the deep tissues, dry tissue secretions and normalize kapha and vata. Daily consumption of tulsi is said to prevent disease, promote general health, wellbeing and longevity and assist in dealing with the stresses of daily life. Tulsi is also credited with giving luster to the complexion, sweetness to the voice and fostering beauty, intelligence, stamina and a calm emotional disposition (Cohen, 2014) [14]. Several studies reveal that tulsi has a unique combination of actions that include: Antimicrobial (including antibacterial, antiviral, antifungal, antiprotozoal, antimalarial, anthelmintic), mosquito repellent, anti-diarrheal, anti-oxidant, anti-cataract, anti-inflammatory, chemopreventive, radioprotective, hepato-protective, neuro-protective, cardio-protective, anti-diabetic, anti-hypercholesterolemia, anti-hypertensive, anti-carcinogenic, analgesic, anti-pyretic, anti-allergic, immunomodulatory, central nervous system depressant, memory enhancement, anti-asthmatic, anti-tussive, diaphoretic, anti-thyroid, anti-fertility, anti-ulcer, anti-emetic, anti-spasmodic, anti-arthritic, adaptogenic, anti-stress, anti-cataract, anti-leukodermal and anti-coagulant activities (Maharajan *et al,* 2013; Mohan *et al.,* 2011) [45]. The orthomyxoviruses (influenza viruses) constitute the genus *Orthomyxovirus*, which consists of three types (species): A, B, and C. These viruses cause influenza, an acute respiratory disease with prominent systemic symptoms. Pneumonia may develop as a complication and may be fatal, particularly in elderly persons with underlying chronic disease (Couch, 1996) [15]. Another economically important viruses are paramyxovirus. *Paramyxovirus*, which includes the parainfluenza viruses and mumps virus; *Pneumovirus*, which includes respiratory syncytial virus; and *Morbillivirus*, which includes the measles virus (Enders, 1996) [18].

Patil (2018) [48] reported the antiviral activity of aqueous, ethanol, methanol and chloroform extract of powdered tulsi drugs through evaluation against economically important viruses of veterinary importance, Orthmyxovirus and Paramyxovirus. The *in vitro* cytotoxicity confirmed the safety of the extracts and aqueous extract showed no inhibition on paramyxovirus while showing moderate inhibitory activity on orthomyxovirus while ethanol extract showed moderate inhibitory activity on paramyxovirus and no activity on orthomyxoviruses. Methanol extract showed no inhibition of paramyxovirus while showed significant inhibition of orthomyxovirus. Chloroform extract of the plant showed no inhibition paramyxovirus while significant inhibition was observed on orthomyxoviurs. Results of the study suggest that the *O. sanctum* can be used as antiviral agent for effective control of viral infections of animal importance.

Conclusion

On reviewing the nutraceutical and therapeutical potentials of major horticultural crops recommended for improving immunity which are utilized in our daily diet, we come to a thought that the vegan diet is very unique and reasonable in maintain one persons physical health. The production of various fruits, vegetables, spices, medicinal crops for basic food diet as well as nutritious local vegetables is possible in India makes the diet more nutritious. Proper diet are necessary in tackling viral diseases rather than treating with drugs. Nutritional supplement is necessary to effectively counter viral illness and their ill effects. Hence a diet with a combined immune boosting and antiviral effects are important.

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