



The role of nutrition in the management of health and diseases

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Received 01 April 2024; revised received 24 June 2024; accepted 25 June 2024

Dietary interventions exhibit promising efficacy in managing diverse chronic conditions and diseases. However, strong evidence and a structured framework are crucial before incorporating dietary interventions into health systems for their best effectiveness and success. This comprehensive review examines the health benefits of incorporating fruits, vegetables, nuts, herbs, and spices into dietary intake. These natural foods are abundant sources of essential vitamins, minerals, antioxidants, and anti-inflammatory compounds, offering a holistic approach to improving overall health and combating multiple diseases. The phytochemicals present in fruits and vegetables play a crucial role in promoting health by exerting antioxidant, anticancer, cardioprotective, immunomodulatory, anti-inflammatory, and effects within the human body. Particular attention has been paid to spices commonly found in Indian kitchens, such as turmeric, ginger, garlic, cinnamon, pepper, and cloves, which have been shown to possess significant therapeutic properties for managing various ailments. Regularly consuming these plant-based foods provides a natural and effective means of obtaining these health-promoting phytochemicals. In conclusion, this review underscores the importance of embracing a plant-rich diet to harness the numerous health benefits of fruits, vegetables, nuts, herbs, and spices. Overall, the findings describe the critical role of dietary choices in disease prevention and management, highlighting the potential of food in promoting long-term health and well-being.

Keywords: Diet, Fruits, Management of health and diseases, Nuts, Spices, Vegetables

IPC code; Int. cl. (2021.01)– A61K 36/00, A61P

Introduction

Chronic illnesses, such as diabetes, cardiovascular conditions, and respiratory disorders, are prevalent and present significant challenges to individuals and healthcare systems worldwide. Managing chronic diseases is essential for improving health outcomes, reducing complications, and enhancing the quality of life for affected individuals¹.

Recently, the world has witnessed a severe outbreak in the form of SARS-CoV-2. A highly contagious virus responsible for this outbreak was first identified in Wuhan, China, in late December 2019². The World Health Organization (WHO) declared it a global pandemic and named it 'COVID-19'. Clinical evidence indicated that certain dietary interventions and proper nutrition can serve as complementary therapies in managing COVID-19 symptoms. These interventions may bolster individual immunity or impede the virus during its initial stages of entry, penetration, adsorption, or replication in the human body³.

Several nutritional items play a crucial role in

managing various diseases by leveraging the power of diet and nutrition to support medical conditions effectively⁴. In recent years, there has been a growing recognition of the intricate relationship between diet, nutrition, and health outcomes, highlighting the importance of nutrition in disease prevention and management⁵. Daily food items like fruits and vegetables are enriched with phytonutrients and fibres, which form the basis of health and protect the body from various ailments⁶. They are enriched with nutrients and non-nutrients, and both play a synergistic role in overcoming the dysfunction of the body's normal processes. They are much needed in the normal human diet, as suggested by the Dietary Guidelines of India and WHO, which states that consuming 400 g of fruits and vegetables per day is necessary for maintaining the overall wellness of the human body^{6,7}. They are rich sources of vitamins, minerals, dietary fibres, carbohydrates, proteins, fatty acids, and bioactive constituents like phenolic acids and flavonoids, making them an indispensable component of the human diet⁸. Fibers increase insulin sensitivity and decrease insulin resistance. It also decreases cholesterol levels⁹. Vitamins act as anti-inflammatory,

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decrease lipogenesis, and increase lipolysis¹⁰. Minerals like magnesium and potassium stabilize blood pressure¹¹. Polyphenols, including phenolic acids and flavonoids, act as antioxidants¹². Other phytonutrients detoxify the body, maintain microbiota for good health, and potentiate the immune system^{13,14}.

The bioactive constituents present in fruits and vegetables play an important role in boosting immunity and thus preventing many chronic illnesses like cancer, hypertension, diabetes, inflammation, and COVID-19^{15,16}.

Moreover, a recent report indicates that the COVID-19 pandemic has substantially affected food consumption behaviours and lifestyles among rural older adults in India, resulting in decreased food intake, weight loss, and deteriorating health conditions. This highlights the urgent need for targeted interventions to address food insecurity and health challenges in this vulnerable population¹⁷. Thus, it is important to include all commonly used food items in day-to-day life that have beneficial actions against complex diseases.

Dietary food items such as fruits, vegetables, spices, and nuts serve as cornerstones of a healthy diet, offering protection against various ailments and bolstering immunity. Moreover, addressing lifestyle

factors and promoting the consumption of nutrient-rich foods are essential steps in mitigating the risk of chronic diseases and fortifying immunity against infectious threats. By prioritizing holistic approaches to health that incorporate nutrition as a cornerstone, we can strive toward a healthier and more resilient global population.

Dietary alternatives for treating various illnesses

Nutritional alternatives are well-established approaches for alleviating, managing, and even treating certain medical conditions. It has been proven effective for many common chronic illnesses. The health benefits of some major categories of our diet, including fruits, vegetables (Fig. 1), spices, and nuts (Fig. 2) (Table 1), are well documented. The structures of several key phytochemicals found in foods that aid in the prevention and management of various diseases are illustrated in Fig. 3.

Fruits

Fruits play a significant role in preventing and treating various complex diseases, particularly cardiovascular diseases (CVDs) and other complex diseases like cancer and diabetes. Research indicates that fruits like grapes, blueberries, pomegranates,

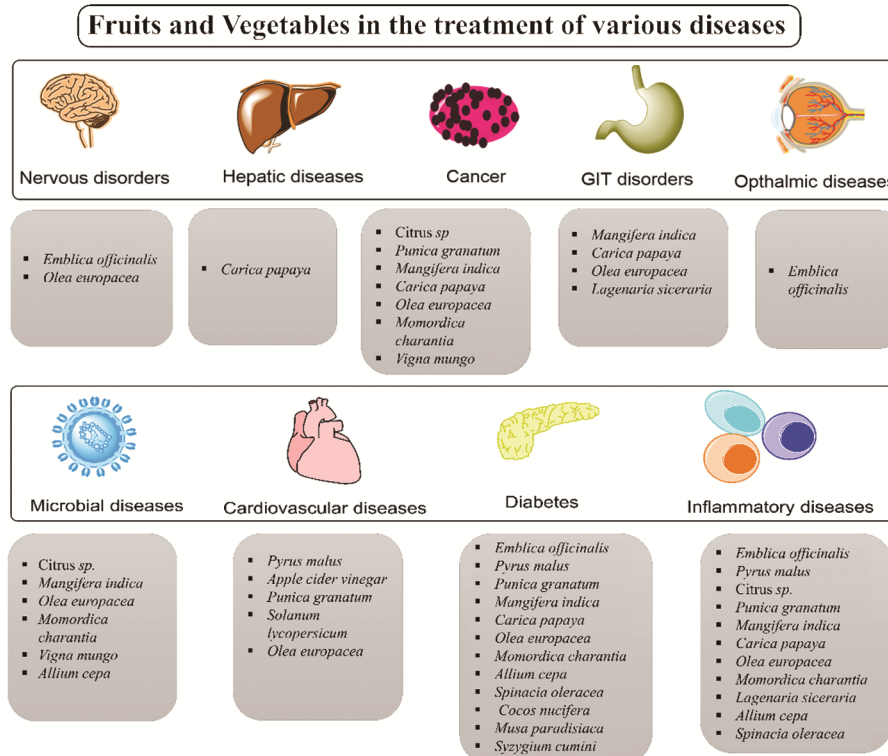


Fig. 1 — Effects of fruits on diverse health conditions.

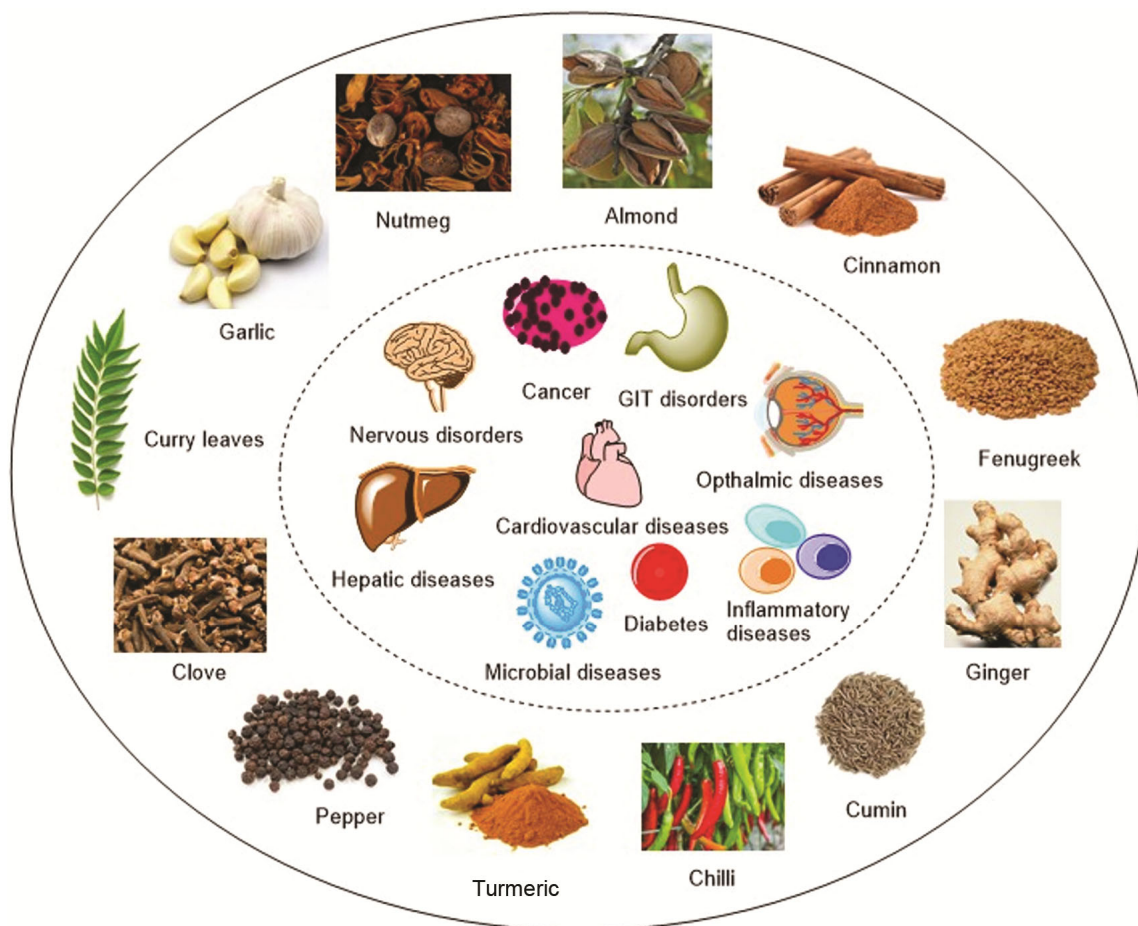


Fig. 2 — Potential role of spices and nuts in various diseases.

apples, hawthorn, and avocado have protective effects on cardiovascular function¹⁵. Thus, consuming a diet rich in fruits and vegetables can lower the risk of heart disease, cancer, inflammation, and diabetes. Citrus fruits such as berries, apples, stone fruits, pomegranates, and grapes are especially beneficial for their anti-inflammatory properties¹⁶ (Fig. 1).

Emblica officinalis

Emblica officinalis (Amla), also recognized as Indian gooseberry, is significant in Ayurvedic medicine. The *E. officinalis* tree typically reaches a height of 3.5–16 feet. It features light grey bark, clustered flowers, feathery leaves, and greenish-yellow fruits containing a stony seed¹⁸. The fruit possesses an astringent and sour taste and is valued for its medicinal and nutritional properties. It stands out as a primary source of vitamin C and minerals compared to other citrus fruits. All components of the plant are utilized medicinally, but the fruits play a pivotal role in Rasayana therapy, either combined

with other herbs or used alone, aiding in the prevention of various infectious and non-infectious ailments. In India, during the winter season, fruits are consumed for their anti-inflammatory and antipyretic properties¹⁹. Since ancient times, amla has been documented for its therapeutic applications in managing a spectrum of ailments such as hyperlipidemia, diabetes, central nervous system disorders, ophthalmic conditions, and more. It boasts a rich nutritional profile comprising amino acids, vitamins, and an array of bioactive compounds, including flavone glycosides, flavonol glycosides, phenolic glycosides, phenolic acids, terpenoids, carbohydrates, and tannins¹⁹.

Pyrus malus and apple vinegar

Pyrus malus (Apples) are widely consumed fruits globally and are known for their ubiquity. They primarily consist of water (85%) and carbohydrates (14%), alongside essential components such as fibre, sugar (mainly fructose), vitamins, minerals, and

Table 1 — Food items that aid in enhancing immunity to prevent various diseases

Botanical name/family	Local name / English name	Food items	Active form/constituents	Important Action	Reference
			Fruits		
<i>Mangifera indica</i> L./ Mangifera	Mango	Mango	Mangiferin, carbohydrates, proteins, amino acids, fatty acids, organic acids, vitamins, minerals, and polyphenols	Antioxidant	118
<i>Citrus sinensis</i> (L.) Osbeck / Rutaceae	Sweet orange,	Sweet orange	Linoleic, linolenic acids, vitamin C, minerals, phenolic compounds (hesperidin)	Antioxidant	24,119
<i>Citrus grandis</i> Hassk. / Rutaceae	Pomelo, chakotra	Pomelo, chakotra	Dietary fibre, vitamin C, vitamin B complex, flavonoids (naringin)	Antioxidant	25
<i>Citrus paradisi</i> Macfad / Rutaceae	Grapefruit,	Grapefruit	polyphenols (Naringin, neohesperidin), vitamin C, fibre	Antioxidant	120
<i>Vitis vinifera</i> L./ Vitaceae (grape, grapevine)	Grape, grapevine,	Grape	Dietary fibre, protein, lipids, vitamins, minerals, phenolic compounds (tannins, phenolic acids, anthocyanins, and resveratrol), hesperidin	Antioxidant	121,122
<i>Citrus limon</i> (L.) Burm. F./ Rutaceae	Lemon	Citrus fruit	Rich source of vitamin C, limonoids	Lipid-lowering	123,124
<i>Eugenia jambolana</i> Lam./ Myrtaceae	Black plum	Jamun	Tannins, ellagic acid, gallic acid, protein, fiber, vitamins, minerals	Sugar lowering	29,125
<i>Musa paradisiaca</i> L./ Musaceae	Banana, plantain	Kela	Phenolics, carotenoids, biogenic amines and phyosterols	Antioxidant	34
<i>Citrus aurantium</i> L./ Rutaceae	Orange	Orange	Flavonoids, vitamin C, hesperidin, naringenin,	Antioxidant	122,126
<i>Emblica officinalis</i> Gaertn./ Phyllanthaceae	Gooseberry	Amla	Vitamin C, fatty acids, minerals, emblicanin A and emblicanin B, pedunculagin and punigluconin	Immunomodulator	127,128
<i>Pyrus malus</i> L./ Rosaceae	Apple	Apple	Fibres, chlorogenic acid, phloridzin, kampferol-3-glucoside, quercetin-3-rhamnoside, catechin	Cholesterol-lowering	129,20,130
<i>Pyrus malus</i> L./ Rosaceae	Apple vinegar	Apple vinegar	Pectin, vitamin B1, vitamin B2, and vitamin B6, biotin, folic acid, niacin, pantothenic acid and vitamin C	Reduce LDL, triglyceride and cholesterol level	131
<i>Cocos nucifera</i> L./ Arecaceae	Coconut	Coconut (coconut water, coconut oil, coconut milk, coconut honey, coconut flowers)	Coconut milk contains water (50%), fat and protein	Anti-inflammatory, cholesterol-lowering	52,54
<i>Carica papaya</i> L./ Caricaceae	Papaya	Papaya	Cryptoxanthin, and β -carotene, cryptoflavin	Anti-inflammatory, immunostimulant	132,133
<i>Punica granatum</i> L./ Lythraceae	Pomegranate	Pomegranate	Ellagic acid, punicalin, punicalagin, pedunculagin	Antioxidant	46,122
			Vegetables		
<i>Capsicum annuum</i> L./ Solanaceae	<i>Capsicum</i>	Green chillies	Capsaicin, ascorbic acid	Antioxidant	86,134
<i>Aegle marmelos</i> (L.) Correa/ Rutaceae	Bael	Bael	Dietary fibers, minerals, vitamins, gallic acid, ascorbic acid	Sugar lowering, lipid-lowering	135,136, 137
<i>Allium cepa</i> L./ Amaryllidaceae	Onion, Shallot	Onion	S-methyl-L-cysteine sulphoxide, S-allyl cysteine sulphoxide, quercetin, kaempferol	Cholesterol-lowering	138
<i>Spinacia oleracea</i> L./ Chenopodiaceae	Spinach	Spinach	Fibre, vitamins and minerals, fatty acids (alpha- linolenic acid, linoleic acid, oleic acid), polyphenols	Antioxidant	70,139

(Contd.)

Table 1 — Food items that aid in enhancing immunity to prevent various diseases (*Contd.*)

Botanical name/family	Local name / English name	Food items	Active form/constituents	Important Action	Reference
<i>Solanum lycopersicum</i> L./ Solanaceae	Tomato	Tomato	Lycopene, β -carotene, lutein, flavonoids, ascorbic acid, dehydroascorbic acid, vitamin C	Antioxidant	140,141
<i>Vigna mungo</i> (L.) Hepper var. mungo (urd bean, black gram), <i>Glycine max</i> (L.) Merr. (soybean), <i>Phaseolus vulgaris</i> L. var. vulgaris (haricot, kidney bean, French bean) / Fabaceae	Urd or black gram, French bean, kidney bean, haricot bean, soybean	Beans	Protein, fibres, polyphenols	Antioxidant	63,64
<i>Momordica charantia</i> L./ Cucurbitaceae	Bitter gourd	Karela	Charantin, vitamin C, momordicosides	Anti-diabetic	142,143
<i>Murraya koenigii</i> (L.) Spreng.	Curry leaves	Curry leaves	Spices Essential oil: sabinene, linalool	Antioxidant, anti-diabetic	102,144
<i>Piper nigrum</i> L./ Piperaceae	Pepper	Black pepper	Piperine	Immunomodulator	145,146,147
<i>Syzygium aromaticum</i> (L.) Merr. & L. M. Perry/ Myrtaceae	Clove	Clove	Eugenol	, anti-inflammatory Anti-inflammatory, antipyretic	148,149
<i>Cuminum cyminum</i> L./ Apiaceae	Cumin	Cumin seeds	Fat (especially monounsaturated fat), protein, dietary fibre, vitamins B and E, minerals, cuminaldehyde cymene and terpenoids	Anti-inflammatory, lipid lowering	80,150,151
<i>Myristica fragrans</i> Houtt./Myristicaceae	Nutmeg	Nutmeg	Eugenol, isoeugenol, myristicin, trimyristicin	Anti-inflammatory	152
<i>Cinnamomum zeylanicum</i> Blume/ Lauraceae	Dalchini	Dalchini	Cinnamaldehyde	Sugar lowering	153,154
<i>Trigonella foenum-graecum</i> L./ Fabaceae	Methi	Fenugreek	Trigonelline	Lipid-lowering, sugar lowering	155,156
<i>Allium sativum</i> L./ Amaryllidaceae	Garlic, lasun	Garlic	Alliin, allicin, diallyl sulphide, vitamin E	Antidiabetic	157,158,159
<i>Zingiberofficinale</i> Roscoe/ Zingiberaceae	Ginger	Ginger	Gingerols and shogaol	Antioxidant, anti-inflammatory	160,161
<i>Curcuma longa</i> L./ Zingiberaceae	Turmeric	Haldi	Curcumin	Anti-inflammatory immunomodulatory	162,163
<i>Prunus amygdalus</i> Batsch / Rosaceae	Almond	Badam	Nuts Palmitic acid, oleic acid, linoleic acid, vitamin E, minerals	Nutritive, cholesterol-lowering	164,165
<i>Camellia sinensis</i> (L.) Kuntze/ Theaceae	Green tea	Green tea	Beverages Xanthic bases (caffeine, theophylline), phenolics, flavonoids (catechins), minerals, vitamins (B, C, E)	Antioxidant	166
<i>Coffea arabica</i> L./ Rubiaceae	Coffee	Coffee seeds	Chlorogenic acid, caffeine	Antioxidant	167
----	Milk	Milk	Calcium, protein, vitamin D, fatty acids, and minerals	Prevent osteoporosis	168

polyphenols. Polyphenols found in apples exhibit positive impacts on various health concerns. Research has highlighted diverse pharmacological activities, such as antioxidant, anti-inflammatory, anti-diabetic, and cholesterol-lowering properties²⁰. Apples, renowned for their abundance in vitamins C and E, fibres, potassium,

and polyphenols, have been linked to favourable outcomes in combating cardiovascular diseases and cancer²¹. The reduced risk of cardiovascular diseases has been associated with the combined effects of fibres and polyphenols, while pectin has been noted for its cholesterol-lowering effects (Table 1).

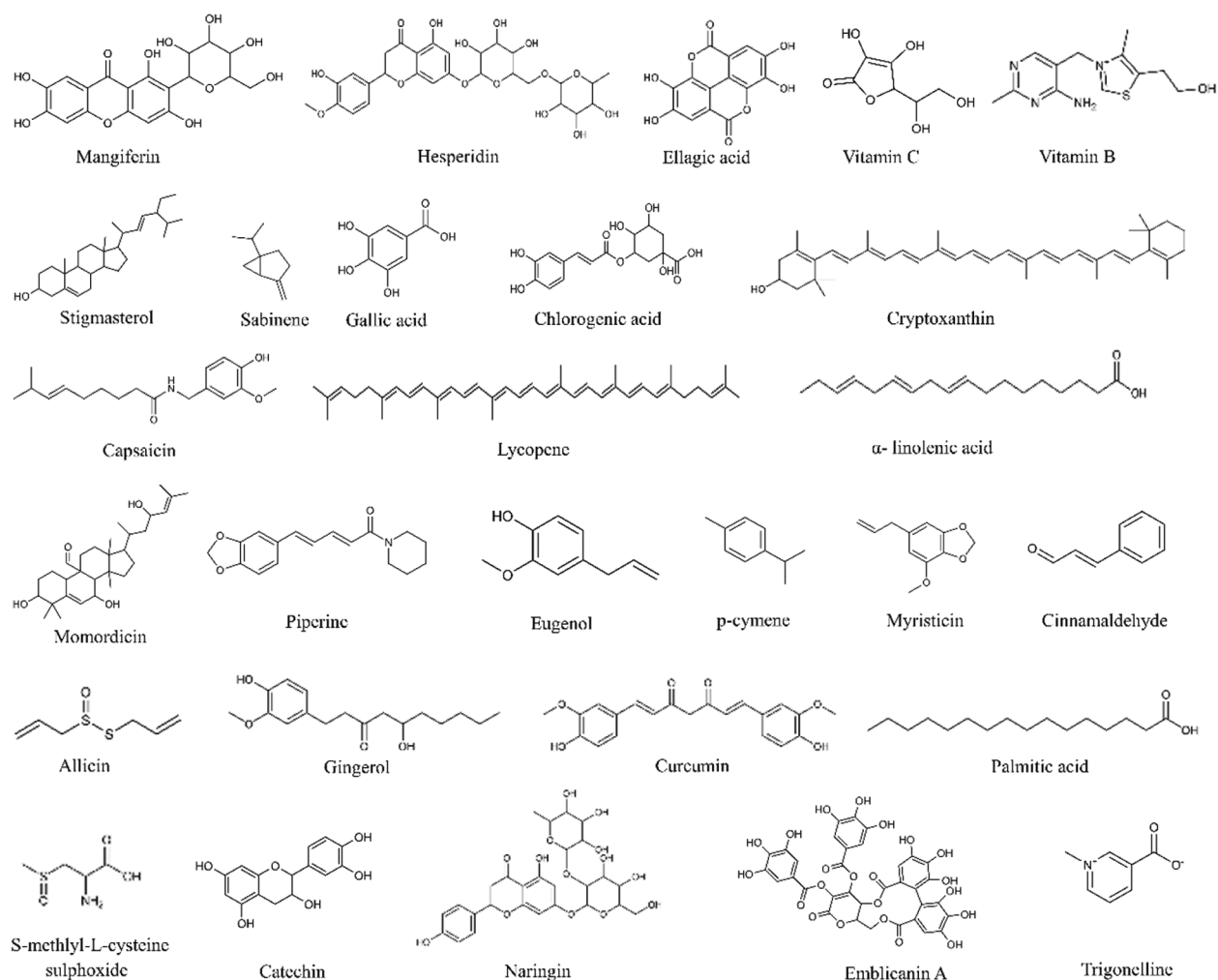


Fig. 3 — Structures of phytochemicals for disease prevention and management.

Citrus sp

Citrus fruits are widely consumed globally and are rich in bioactive compounds that offer various health benefits. These fruits are a significant source of phytoactive compounds such as carotenoids, flavonoids, limonoids, folates, coumarin compounds, essential oils, vitamin C, dietary fibre, and pectin. Examples of citrus fruits include oranges, lemons, limes, grapefruits, and tangerines. These fruits also play a crucial role in preventing health issues due to their pharmacological properties, which include antioxidant, anti-inflammatory, anticancer, cardiovascular protection, and metabolic disease benefits²³. Citrus fruits are rich in polyphenols and renowned for their antioxidant qualities. These fruits also demonstrate various pharmacological benefits, encompassing antitumor, anti-clotting, antiatherogenic, and antihyperlipidemic properties²³⁻²⁵ (Table 1).

Syzygium cumini

The evergreen *Syzygium cumini* (Jamun), belonging to the Myrtaceae family, is renowned for its fruits. The tree typically reaches heights of about 50 feet. Its fruits grow in clusters, each containing a central seed and imparting astringent flavours upon consumption. Notably, consuming these fruits results in a purplish discolouration of the tongue²⁶. The fruits are highly esteemed for their nutritional richness and gastronomic appeal. Additionally, they serve as key ingredients in various products like squashes, health beverages, jellies, and juices. Famous for their dietary benefits, these fruits boast abundant vitamins, minerals, carbohydrates, natural sugars, and amino acids. Furthermore, they contain many bioactive compounds, such as phenolics, flavonoids, phytosterols, and terpenes. Their medicinal applications are documented in traditional medicinal systems such as Unani, Ayurveda, Siddha, and

Homeopathy²⁷. Jamun has been used to treat diabetes for centuries, even before the discovery of insulin²⁸. Its other applications extend to serving as a liver tonic, aiding in dentistry, acting as a haematinic, and alleviating excessive body heat. Jamun exhibits diverse pharmacological effects, including antibacterial and antifungal properties, antioxidant activity, anti-inflammatory effects, hypoglycemic action, hepatoprotective qualities, and potential anti-cancer properties²⁹ (Table 1).

Musa paradisiaca

Musa paradisiaca (Banana) is a widely consumed fruit and is of significant importance as a global food crop. It is borne by an evergreen perennial herb classified within the Musaceae family. India, the Philippines, China, and Ecuador are the main producers of bananas³⁰. Bananas are parthenocarpic fruits with both edible pulp and outer peel, each carrying nutritional benefits. It is an important source of phytonutrients like phenolic compounds, vitamins, and other components like minerals, dietary fibres, and starch³¹. It is a staple food in many countries because of its high nutritional value and beneficial effects on human health. Their iron content makes bananas suitable for anaemic patients, while their high potassium and low salt levels aid in blood pressure regulation³². The presence of serotonin contributes to its effectiveness in combating depression, and its resistant starch content is beneficial for diabetic patients, along with its hypocholesterolemic properties³³. Bananas also exhibit antihyperglycemic effects and are utilized as an anti-diabetic remedy. Additionally, their carotenoid content makes them valuable in addressing vitamin A deficiency disorders³³. Overall, bananas stand out as one of the most important antioxidant-rich fruits³⁴ (Table 1).

Mangifera indica

The *Mangifera indica* (Mango) tree, characterized by its evergreen nature, can reach heights ranging from 8 to 40 meters. It features grey bark and broad leaves and produces drupe fruits that vary in shape, size, and colour depending on the variety. In traditional medicine systems, every component of the plant, including leaves, seeds, bark, fruit, and flowers, is employed to treat a variety of ailments such as dysentery, ulcers, leucorrhoea, syphilis, dyspepsia, and anaemia³⁵. Mangoes are esteemed as a fruit crop with significant nutritional worth, boasting a wealth of macronutrients, micronutrients, and bioactive

compounds³⁶. Mango fruit is rich in macronutrients such as carbohydrates, amino acids, proteins, fatty acids, lipids, and organic acids. Vitamins and minerals are also present in the fruit. Additionally, the mango fruit contains various bioactive compounds, including polyphenols, volatile components, phenolics, and pigments³⁵. The polyphenolic compounds in mango, such as mangiferin, catechins, gallic acid, kaempferol, quercetin, ellagic acids, and anthocyanins, are known for their antioxidant and pharmacological activities. These compounds have been reported to exhibit various biological effects, including anti-inflammatory, antimicrobial, antiviral, anticancer, and antioxidant properties³⁷. Mango exhibits significant pharmacological effects, including anti-inflammatory, antioxidant, immunomodulatory, antibacterial, anticancer, antihyperlipidemic, antifungal, antidiabetic, and gastroprotective properties³⁸ (Table 1).

Carica papaya

Carica papaya (Papaya), a versatile plant with dioecious or hermaphrodite varieties, yields economically valuable edible fruits. It is recognized for its rich nutrients. It contains ample minerals, vitamins, and fibre. Its unique flavour is attributed to a variety of volatile compounds, including hydrocarbons, terpenes, alcohols, ketones, aldehydes, benzyl isothiocyanate, esters, and organic acids³⁹. Papaya is rich in protease enzymes, including papain, caricain, glycyndopeptidase III and IV, and chymopapain A and B⁴⁰. Additionally, it contains a diverse array of compounds, such as glycosides, polysaccharides, flavonoids, saponins, lectins, and steroids⁴⁰. Traditional wisdom has identified papaya as a remedy for conditions such as ulcers, dandruff, menstrual irregularities, bacterial infections, and impotence⁴¹. Its ripe fruit serves as a diuretic, carminative, sedative, and expectorant, utilized for ailments like dysentery and various skin conditions⁴¹. Papaya latex has applications in treating dyspepsia and as an external remedy for wounds⁴². The bioactive compounds within it exhibit diverse pharmacological effects, including anti-inflammatory, wound healing, anticancer, antioxidant, gastric disorder management, and anthelmintic properties⁴² (Table 1).

Punica granatum

Punica granatum (Pomegranate) fruit is frequently enjoyed fresh or as juice and serves as both a

flavouring and colouring agent in various beverages, jellies, syrups, and jams. Its significance has grown as a prominent commercial fruit crop due to its exceptional nutritional profile⁴³. In traditional medical systems such as Ayurveda and Unani, pomegranate is mentioned for its medicinal properties, acting as a blood tonic, antiparasitic agent, and ulcer treatment. The fruit is rich in chemical constituents, including sugars, vitamins, polyphenols, polysaccharides, minerals, acids, and lignins. Notable bioactive compounds within the fruit encompass anthocyanins, punicalin, ellagic acid, punicalagin, and pedunculagin⁴⁴. The bioactive constituents exhibit pharmacological effects such as antioxidant, anti-inflammatory, antidiabetic, and anticancer properties^{45,46} (Table 1).

Solanum lycopersicum

Solanum lycopersicum (Tomato), a perennial plant from the Solanaceae family, typically reaches heights of 1-3 feet. Often regarded as both a fruit and a vegetable, it is consumed either raw or as a fundamental ingredient in numerous culinary dishes. Notably, tomatoes are a significant dietary source of lycopene and various carotenoids⁴⁷. The other major carotenoids include neoxanthin, α -cryptoxanthin, violaxanthin, β -cryptoxanthin, zeaxanthin, carotene, lutein, and phytoene. β -cryptoxanthin, α -carotene, and β -carotene possess provitamin A activity. Tomatoes consumption is related to the reduced risk of cardiovascular diseases and cancer⁴⁸. Tomatoes claim a nutritional composition primarily composed of water (94%), accompanied by proteins, minerals, carbohydrates, dietary fibres, and vitamins. Its principal active component, tomatine, plays a key role in lowering LDL cholesterol levels. Additionally, tomatoes contain various classes of compounds, such as polyphenols, tannins, flavonoids, and anthocyanins. Incorporating tomatoes into one's diet helps alleviate oxidative stress and reduces the risk of coronary heart disease⁴⁹ (Table 1).

Olea europaea

Olea europaea (Olive), owing to its bitter flavour, is typically not consumed as a fresh fruit but rather enjoyed in the form of table olives or olive oil. Its medicinal significance is recognized in traditional medicine systems, where it has been employed as a folk remedy for a range of ailments, including elevated blood sugar, uric acid, cholesterol, hypertension, diarrhoea, inflammation, urinary infections, gastrointestinal disorders, haemorrhoids, asthma, and

as a mouth rinse and laxative⁵⁰. The important chemical constituents present in olive are iridoids, secoiridoids, and oleuropein. Other phytochemicals include flavonoids, triterpenoids, flavone glycosides, flavanones, sterols, and sugars⁵⁰. The major phytoconstituents are responsible for various pharmacological activities such as anticonvulsant, antidiabetic, immunomodulatory, anti-inflammatory, antimicrobial, analgesic, antihypertensive, antiviral, anticancer, gastroprotective, antioxidant, and wound healing⁵¹ (Table 1).

Cocos nucifera

Cocos nucifera (Coconut) is utilized commercially in the form of oil and coconut milk in the food industry. Coconut oil and coconut endosperm are used as cooking ingredients in many Southeast Asian cuisines, such as India⁵². Coconut water denotes the watery liquid found within the endosperm, while coconut milk or cream represents the fibre-free aqueous substance derived from the endosperm. This extract can take the form of either coconut cream or coconut milk. Coconut milk is a white, opaque emulsion of protein in an oil-in-water composition obtained by pressing grated endosperm⁵³. Comprising approximately 50% water along with fats, proteins, minerals, vitamin B, and ascorbic acid, coconut milk offers a rich nutritional profile. It has been associated with several pharmacological benefits, such as anti-inflammatory, antioxidant, antidiabetic, and antibacterial properties. Furthermore, it has demonstrated promising effects in managing cardiovascular disorders, fatty liver, and lowering lipid levels^{52,54} (Table 1).

Vegetables

Vegetables play a crucial role in preventing various complex diseases due to their high content of bioactive compounds such as dietary fibres, vitamins, minerals, and phytochemicals⁵⁵. Research indicates that increasing the consumption of vegetables can significantly reduce the risk of chronic diseases like hypertension, coronary heart disease (CHD), and stroke⁵⁶. These findings underscore the importance of promoting vegetable consumption as a vital strategy for improving health and preventing diseases⁵⁶ (Fig. 1).

Momordica charantia

Momordica charantia (Karela), known as bitter melon or gourd, belongs to the family Cucurbitaceae. *M. charantia* serves multiple health

purposes, notably as a popular source of fresh juice renowned for its anti-diabetic properties. The bitterness of *M. charantia* is attributed to Momordicosides K and L, along with Momordicines I and II. In Asian nations, *M. charantia* is commonly prepared and consumed as a vegetable or brewed into herbal tea. It is rich in minerals, vitamins, flavonoids, phenolic acids, peptides, alkaloids, and saponins, which show significant pharmacological effects, including antimicrobial, anticancer, hypolipidemic, wound-healing, immunomodulatory, hypercholesterolemic, analgesic, and anti-inflammatory properties⁵⁷ (Table 1).

Lagenaria siceraria

Lagenaria siceraria (Lauki), also known as the bottle gourd, is a climbing vine that produces edible fruits commonly consumed as vegetables. This plant has been utilized in traditional systems of medicine for centuries, offering numerous health benefits to humans⁵⁸. Lauki contains phytochemicals like saponins and vitamins such as vitamin C, which act as antioxidants. These compounds help in scavenging free radicals, reducing oxidative stress, and potentially protecting cells from damage⁵⁹. The lauki juice may help manage cholesterol levels. The phytochemicals present in the plant, such as saponins, may increase lipoprotein activity, aiding in the removal of harmful fatty acids from the blood. This action could potentially contribute to lowering cholesterol levels⁶⁰ (Table 1).

Beans

Beans come under the category of legumes and belong to the family Fabaceae. Beans are a significant part of the human diet due to their high nutritional value and rich source of protein. They contain various bioactive compounds such as cyanogenic glycosides, alkaloids, peptides, amines, isoflavonoids, phenylpropanoids, anthocyanins, catechins, tannins, coumarins, lignans, terpenoids, and anthraquinones⁶¹. These compounds have been reported to exhibit various biological effects, including antioxidant, anti-inflammatory, antimicrobial, and anticancer properties⁶². These secondary metabolites present in beans exhibit a broad spectrum of pharmacological activities, encompassing antioxidant, anti-inflammatory, anticancer, and phytoestrogenic properties. However, most of the physiological effects of beans are ascribed to their elevated levels of phytoconstituents, particularly phenolic acids and

flavonoids. Commonly consumed beans in India include *Vigna mungo* (L.) Hepper var. mungo (urd bean, black gram), *Glycine max* (L.) Merr. (soybean), and *Phaseolus vulgaris* L. var. *vulgaris* (haricot, kidney bean, French bean)^{63,64} (Table 1).

Allium cepa

Allium cepa (Onion) are herbaceous biennial plants grown for their edible bulbs. They are low in nutrients but valued for their flavour and are widely used in cooking, adding taste to dishes like stews, roasts, soups, and salads⁶⁵. It belongs to the Amaryllidaceae family and comprises inner fleshy layers surrounded by outer scaly leaves, forming a flattened globe shape. It is available in various hues, including red, white, yellow, and green; it is distinguished by its characteristic pungent aroma⁶². As one of the oldest vegetables globally, onion has attained economic significance as a crop. It is frequently utilized in its fresh form, with shoots serving as raw salads or cooked as vegetables, and finds application in processed foods and pickles. It is rich in bioactive compounds, such as flavonoids (kaempferol), phenolic acids, anthocyanins, and organosulfur compounds⁶⁵. Onion has been traditionally used to treat a wide range of ailments, including skin diseases, digestive problems, insect bites, metabolic diseases, scurvy, and as a blood purifier⁶⁶. The pungent odour and characteristic taste of onion are due to the presence of organosulfur compounds such as alliin, allicin, and diallyl sulfide⁶⁷. These bioactive compounds present in onion are linked to various pharmacological activities, such as antioxidant, antimicrobial, analgesic, anti-diabetic, anti-inflammatory, hypolipidemic, immunoprotective, and anti-hypertensive effects⁶⁷ (Table 1).

Spinacia oleracea

Spinacia oleracea (Spinach) is a dark green leafy vegetable that is regarded as a functional food with high nutritional value and belongs to the family Chenopodiaceae⁶⁸. Spinach is a nutrient-dense leafy green vegetable with a high water content, along with essential macronutrients and micronutrients that contribute to its health benefits and nutritional value⁶⁹. The bioactive compounds present in spinach include flavonoids such as spinacetin, patuletin, jaceidin, spinatoside, and flavone, along with phenolic acids like hydroxycinnamic acid and hydroxybenzoic acid⁷⁰. These compounds are associated with various pharmacological activities, including anti-

inflammatory, antioxidant, anti-obesity, anti-proliferative, lipid-lowering, and hypoglycemic effects⁷⁰ (Table 1).

Spices

The use of spices in the treatment of various diseases has been a longstanding practice due to their medicinal properties and health benefits. Spices like turmeric, clove, black pepper, cinnamon, and chilli pepper have been traditionally utilized for their antioxidant, anti-inflammatory, and immunomodulatory effects, which play a role in preventing and treating diseases such as cancer⁷¹ (Fig. 2).

Piper nigrum

Piper nigrum (Pepper) (Family: Piperaceae) is known as the "spices king" due to its extensive use. The genus *Piper* encompasses more than 1000 species, with *P. longum* and *P. betle* being among the most common ones⁷². *P. nigrum* fruits are cultivated in India and are used to produce green and white pepper, which are of wide importance due to the presence of a bioactive compound piperine⁷³. Black pepper consumption stimulates the secretion of digestive enzymes from the pancreas and intestine, which helps in the digestion of food⁷⁴. It has a rich history of ethnobotanical uses, being employed for its medicinal properties in treating digestive disorders, respiratory infections such as fever, cold, and asthma, as well as conditions like rheumatism, gastric ulcer, and as an antiviral agent. Pharmacological research has revealed a myriad of properties associated with black pepper, including thermogenic action, anti-inflammatory effects, anti-thyroid activity, antimicrobial properties, insecticidal qualities, chemoprotective benefits, and anaesthetic potential⁷⁵ (Table 1).

Syzygium aromaticum (Clove)

Clove is derived from the dried flower bud of *Syzygium aromaticum* and belongs to Myrtaceae family. The leaves and buds of the clove tree constitute its commercially valuable parts. Its oil typically presents as colourless or pale yellow, boasting a distinctive flavour. Notably, cloves are favoured as a natural preservative owing to their antioxidant and antimicrobial characteristics, replacing chemical preservatives in certain applications⁷⁶. Traditionally, clove oil has been applied in the healing of wounds and burns, serving as an analgesic for tooth infections. In both Indian and Chinese Systems of Medicine, clove has been documented as a stimulant and warming agent. Ethnobotanical practices demonstrate

its effectiveness in addressing issues such as flatulence, vomiting, gastrointestinal disorders, nausea, scabies, malaria, cholera, and tuberculosis, as well as its use as a nervine stimulant, antimicrobial, antiviral, anticancer, and antioxidant agent⁷⁷. Eugenol stands as the primary active constituent of clove, alongside other compounds such as flavonoids, tannins, hydroxybenzoic acid, hydroxycinnamic acid, and phenolic acids. Clove flower buds harbour approximately 18% essential oils, with eugenol, eugenol acetate, and beta-caryophyllene prevailing as key constituents⁷⁶ (Table 1).

Cuminum cyminum

Cumin, a highly nutritious seed rich in oil, belongs to the Apiaceae family. It consists of paired separate carpels characterized by a striped pattern of ridges and oil canals. While originating from Turkistan, Egypt, and the eastern Mediterranean, cumin has since been introduced to numerous countries including India, China, Iran, southern Russia, Indonesia, Japan, Algeria, Morocco, and Turkey⁷⁸. It is mainly used as a spice in cooking or as an ingredient in spice mixtures and curry powders. Cumin seeds have traditionally been utilized for treating dyspepsia, toothache, epilepsy, diarrhoea, and jaundice. The oil derived from cumin exhibits a spectrum of properties including carminative, diuretic, emmenagogic, antioxidant, antibacterial, anti-diabetic, cytotoxic, and antispasmodic effects⁷⁹. Cumin seeds contain approximately 10% fixed oil, and 1-5% volatile oil, as well as protein, sugar, cellulose, and minerals. The distinct aroma emitted by cumin seeds is attributed to the presence of volatile oil. Cumin oil comprises a variety of compound classes including terpenic hydrocarbons, alcohols, aldehydes, ketones, esters, phenols, and epoxides. Among these, cuminaldehyde, 1-phenyl-1,2-ethanediol, γ -terpinene, β -pinene, and p-cymene are the primary constituents. These compounds are associated with various pharmacological activities of cumin oil, such as anti-inflammatory, antioxidant, antimicrobial, and digestive benefits⁸⁰ (Table 1).

Cinnamomum zeylanicum

Cinnamon is a common spice used all over the world which is obtained from the inner bark of two varieties *Cinnamomum zeylanicum* and *Cinnamomum cassia*. Along with its culinary use, its medicinal properties have also been mentioned in Ayurveda as a remedy for digestive, respiratory, and gynaecological

ailments⁸¹. The leaves of cinnamon contain eugenol, which is known for its broad range of beneficial properties, including antimicrobial, antifungal, antiviral, antioxidant, antitumor, blood pressure-lowering, and anti-diabetic activities. The bark of cinnamon is rich in cinnamaldehyde, which has been shown to possess antiplatelet, anti-hyperglycemic, and cytotoxic effects, making it potentially useful for treating conditions like thrombosis, diabetes, and cancer⁸². The oil obtained from the bark of cinnamon has a spicy aroma and sweet to pungent taste. It is mainly used as a flavouring agent in food, pickles, confectionary, tobacco flavours, and baked goods along with some pharmaceutical applications. Overall, plant shows various pharmacological actions including antimicrobial, anti-inflammatory, antioxidant, and anti-cancer, boost cognitive functions, and reduce cardiovascular diseases⁸² (Table 1).

Capsicum annuum

Chilli, a member of the Solanaceae family, is an annual or perennial shrub available in green and red varieties. Its unique aroma, colour, and flavour have made it a staple ingredient in cuisines worldwide, cherished for generations. Beyond its culinary appeal, chilli holds nutritive significance, serving as a vital source of nutrients in the human diet. This nutritional value is attributed to the presence of antioxidant vitamins such as vitamins A, C, and E⁸³. Its colour is due to the presence of carotenoids which are present in high concentrations. The pungency and spicy taste of chilli is attributed to the presence of a group of compounds known as capsaicinoids. Among these, capsaicin and dihydrocapsaicin constitute 90% of the pungency. Capsaicin refers to be the major compound of chilli along with other compounds such as fats, proteins, carbohydrates, and minerals. Capsaicin is used in various ailments such as diabetic neuropathy, rheumatic diseases, cluster headaches, and post-hepatic neuralgia⁸⁴. Other pharmacological actions of the plant include antioxidant, anti-cancer, anti-viral, and anti-inflammatory^{85,86} (Table 1).

Allium sativum

Garlic is a widely consumed spice and aromatic herb belonging to the family Amaryllidaceae. It is the most common remedy for influenza, cold, and hypertension and is used as a spice to provide a flavour for cooking purposes⁸⁷. Garlic contains various sulfur compounds among which allicin is responsible for the

characteristic taste and smell of garlic and allyl mercaptan is responsible for its specific odour. Other constituents include sulfides, diallyl trisulfide, and ajoenes⁸⁸. Traditionally garlic has been used as a remedy to treat indigestion, urinary tract infection, respiratory disorders, and cardiac disorders, and showed antipyretic, carminative, diuretic, and aphrodisiac effects⁸⁷. The pharmacological actions reported include anti-viral, anti-fungal, antibacterial, anti-protozoal, anti-hypertensive, antioxidant, anti-inflammatory, anti-cancer, immunomodulator, and anti-diabetic⁸⁹ (Table 1).

Curcuma longa (Turmeric)

Turmeric, a tuberous perennial herb, holds significant importance in medicine, economics, and culture. It is widely cultivated in India; it stands as a top producer of this herb. Turmeric is primarily utilized domestically as a condiment⁹⁰. It serves as a colouring agent in a variety of food items, confectionery, and pharmaceuticals. It also acts as a flavouring in rice, meats, and other foodstuffs⁹¹. Apart from its role as a flavour enhancer, turmeric has been historically utilized for its medicinal properties. Traditional medicine systems such as Ayurveda and Chinese medicine recognize turmeric as a healing and cooling agent, beneficial for digestion, and possessing antiseptic, anthelmintic, and tonic properties. Additionally, local communities use turmeric for addressing ailments like scabies, itching, pimples, piles, intestinal worms, urinary issues, gonorrhoea, and as a blood purifier⁹². The primary constituents of turmeric include curcuminoids, such as curcumin and demethoxycurcumin, along with carbohydrates, fats, proteins, and minerals⁹⁰. Curcumin is known for its diverse pharmacological actions, which include anti-inflammatory, anti-diabetic, antioxidant, anti-cancer, and wound healing properties. It has been extensively studied for its beneficial effects on various health conditions⁹³. Curcumin has been found to have positive effects on neurological disorders, autoimmune diseases, skin conditions, and cardiovascular health. Moreover, studies have also highlighted curcumin's potential in preventing new cancers caused by chemotherapy or radiation and its anti-cancer activities through various biological pathways involved in tumor growth and metastasis^{94,95}. It generally targets key signaling pathways involved in cancer progression, such as Wnt/ β -catenin, PI3K/Akt, JAK/STAT, MAPK, p53, and NF- κ B^{94,95}. Curcumin exhibits anti-inflammatory

effects by reducing histamine levels and interfering with inflammatory responses in cells. Additionally, it shows antioxidant properties by scavenging reactive oxygen species and inhibiting lipid peroxidation⁹³. Curcumin blocks the activation of NF- κ B, a key transcription factor that regulates inflammatory genes. It downregulates the production of pro-inflammatory cytokines such as IL-1 β , IL-6, and TNF- α ⁹⁵ (Table 1).

Zingiber officinale

Ginger, a perennial herb from the Zingiberaceae family, is widely recognized for its characteristic flavour, making it a commonly used spice worldwide. Additionally, it serves as a flavouring agent in liquors and carbonated drinks and acts as a preservative in sugar syrups. The bioactive constituents present in ginger are phenolics along with other compounds such as shogaols, gingerols, zingerones, and paradols⁹⁶. This herb holds a prominent place in traditional medicine systems like Ayurveda, Unani, and Chinese medicine, where it is employed to address a range of ailments including rheumatoid arthritis, muscular aches, nausea, sore throat, indigestion, fever, infections, and helminthiasis⁹⁷. When incorporated into a regular diet, ginger functions as a carminative and stimulates the gastrointestinal tract. The rhizome of ginger mainly comprises carbohydrates (60-70%), along with proteins, fibre, and oil. Its distinctive pungent flavour is attributed to the presence of gingerols, zingerone, and shogaols. The volatile oil of ginger is predominantly composed of α -zingiberene, along with other sesquiterpenoids⁹⁶. The major pharmacological activities shown by its active constituents include antitumor, immunomodulatory, anti-inflammatory, antioxidant, anti-hyperglycaemic, anti-emetic, and neurodegenerative diseases^{98,99} (Table 1).

Murraya koenigii

Curry leaves are a short perennial shrub with a potent aroma, curry leaves are abundant in India. These aromatic leaves are primarily utilized as a flavouring agent in sauces and curries. Additionally, they have been historically cited in the Indian system of medicine for treating various ailments. The primary bioactive constituents found in curry leaves are carbazole alkaloids, which exhibit a wide range of pharmacological effects including antioxidant, anti-tumour, anti-inflammatory, anti-mutagenic, and antimicrobial properties¹⁰⁰. The leaves and roots of *Murraya koenigii* find uses in treating piles,

inflammation, thirst, and itching, and are also employed as a tonic, analgesic, anthelmintic, digestive aid, and appetizer¹⁰¹. Curry leaves are aromatic, offering a slightly bitter taste, mild acidity, and a pungent quality with a cooling effect. Moreover, they comprise coumarin glycosides, minerals, vitamins, carotene, and various other constituents¹⁰¹. Essential oil is also used as an important ingredient in aromatherapy products. These essential oils isolated from leaves exhibit antibacterial, antioxidant, larvicidal, hypoglycaemic, anti-carcinogenic, anti-hypertensive, and hypolipidemic activities¹⁰² (Table 1).

Trigonella foenum-graecum

Fenugreek, a plant widely cultivated worldwide, serves as a popular condiment. This annual herb typically reaches a height of 0.3-0.8 m and features trifoliolate leaves, white or yellow flowers, and slender pods containing brown seeds. While the seeds are used as condiments, the leaves are consumed as vegetables in certain Indian communities. In Indian traditional medicine, fenugreek holds significance in treating a range of ailments including fever, bronchitis, swollen glands, diabetes, ulcers, skin irritation, and digestive issues¹⁰³. Furthermore, it is recognized as a functional food with health benefits and therapeutic properties for various conditions¹⁰⁴. Trigonelline stands out as the primary bioactive compound found in fenugreek, accompanied by other constituents such as choline, flavonoids, amino acids, vitamins, fatty acids, saponins, fibres, polysaccharides, and fixed oil. Fenugreek exhibits a wide array of pharmacological effects, including antioxidant, anti-inflammatory, anti-diabetic, anti-neoplastic, anti-ulcerogenic, hypocholesterolemic, immunomodulatory, antipyretic, antibacterial, and antifungal properties¹⁰⁵ (Table 1).

Myristica fragrans

Nutmeg, the seed kernel found within the fruit of the *Myristica fragrans* plant from the Myristicaceae family, is a significant spice. The height of a *M. fragrans* (Nutmeg) plant can vary depending on its maturity and growing conditions. Mature nutmeg plants typically reach around 30 feet tall with a canopy width of about 20 feet, forming an upright structure with tiered branches. The seeds are fleshy, whitish, and ovoid in shape. Nutmeg serves as a vital spice and is also utilized as a flavour enhancer in confectionery, baked goods, vegetables, puddings, and beverages¹⁰⁶. Nutmeg also serves as a crucial

component in tea, curry powder, and soft drinks. Historically, it has been employed to address various ailments including insomnia, diarrhoea, and mouth ulcers, as well as serving as a stimulant, stomachic, carminative, appetizer, emmenagogue, and for relieving flatulence, among others. Additionally, nutmeg's essential oil finds external use in treating inflammations, and rheumatism, and as an analgesic. Major constituents of nutmeg include Myristin, Trimyristin, myristicin, myristic acid, elimicin, and safrole¹⁰⁷. Furthermore, nutmeg contains a variety of other compounds such as saponins, alkaloids, cardiac glycosides, flavonoids, terpenoids, lignin, phlobatanins, phenolics, proteins, and volatile substances¹⁰⁷. It exhibits significant pharmacological effects including anti-convulsant, antioxidant, anti-inflammatory, analgesic, anti-fungal, antibacterial, and anti-diabetic properties¹⁰⁸ (Table 1).

Nuts

Nuts have been recognized for their potential health benefits and have been used in the treatment and prevention of various diseases. Nuts have been associated with a lower risk of cardiovascular disease incidence and mortality among individuals with type 2 diabetes¹⁰⁹. Higher consumption of nuts, especially tree nuts, may be beneficial for cardiovascular health in the population. Nuts contain various components that may contribute to their cancer-fighting abilities, including antioxidants, anti-inflammatory compounds, and phytochemicals that influence gene expression and cell signaling¹¹⁰ (Table 1).

Prunus amygdalus

Almonds, members of the Rosaceae family, rank among the most sought-after tree nuts for commercial purposes. They are enjoyed as whole nuts and are prominently featured in a wide range of processed foods, including confectionery and bakery items. The edible fruit of the almond comprises three parts: an outer green shell cover, a middle shell portion, and the inner kernel. Incorporating almonds into one's diet offers nutritional advantages and has been linked to a decreased risk of various chronic ailments¹¹¹. Almonds exhibit pharmacological effects such as anti-inflammatory, anticancer, sedative, anti-hyperlipidemic, and antioxidant properties. These beneficial activities are attributed to the presence of flavonoids and phenolic compounds within the nut. Almonds are abundant in oleanolic acid, betulinic acid, ursolic acid, triterpenoids, flavonoids, and

phenolic acids, making them a rich source of these bioactive constituents¹¹². Numerous flavonoids and phenolic acids in almonds are linked to sugars or polyols through O-glycosidic bonds or ester bonding. Consistent long-term consumption of almonds has demonstrated a natural adjustment in an individual's regular diet, aligning closely with the dietary guidelines essential for averting cardiovascular and other chronic diseases^{112,113} (Table 1).

Beverages

Beverages like tea and coffee can have both beneficial and detrimental effects on health, depending on the specific disease and drinking patterns. However, consuming tea and coffee should be limited to avoid increasing the risk of gut-related diseases.

Coffea arabica

The coffee plant, belonging to the Rubiaceae family and *Coffea* genus, is a woody perennial tree. Within the *Coffea* genus, there are approximately 70 species, with *Coffea arabica* and *Coffea canephora* being the most prominent. These species vary in appearance, taste, and caffeine content. *Coffea arabica* is the most widely consumed species, constituting approximately 75-80% of global coffee consumption. After water, coffee holds a preeminent position among all beverages in terms of consumption¹¹⁴.

Coffee processing commences with the selection of seeds, followed by drying, roasting, grinding, and ultimately brewing to produce the final product. Decaffeination processes are employed to remove caffeine and lipid fractions. Caffeine stands as the primary constituent of coffee, accompanied by components such as chlorogenic acid, hydroxyhydroquinone, tocopherols, lignans, and minerals. Prominent for its stimulating effects, coffee consumption is linked to heightened alertness and improved concentration. Additionally, it offers various health advantages, including protection against cancer, Diabetes mellitus, cardiovascular diseases, neurological disorders, and DNA damage, while also serving as an antioxidant¹¹⁵ (Table 1).

Camellia sinensis

Tea ranks as the second most consumed beverage globally, following water, and is ingrained both socially and habitually across diverse societies. It originates from an evergreen plant with green leaves, which undergoes various processing methods to yield

distinct types such as green, black, and oolong tea. These teas exhibit differences in appearance, chemical composition, taste, and aroma due to variations in fermentation processes. Among its bioactive constituents are caffeine, theophylline, theobromine, flavonoids, catechins, polysaccharides, volatile oils, lipids, amino acids, vitamins, and minerals¹¹⁶. Green tea boasts epigallocatechin gallate as its primary catechin, accompanied by others like epicatechin, gallic acid, epigallocatechin, and epicatechin gallate. The significant health benefits attributed to tea are largely attributed to its polyphenol content, reaching 30-40% in green tea and 3-10% in black tea. Green tea, derived from unfermented leaves, retains a higher concentration of phytoactive compounds, thus offering greater health advantages compared to black tea. Its pharmacological effects span anti-cancer, anti-diabetic, and antioxidant properties, while also finding utility in managing cardiovascular issues and supporting weight loss efforts¹¹⁷ (Table 1)

Conclusion and future perspective

Dietary intakes including fruits, vegetables, nuts, herbs, and spices are rich in vitamins, minerals, antioxidants, and anti-inflammatory substances that can have numerous health benefits. Consumption of these dietary food items can be a healthy and effective way to improve overall health and prevent various lifestyle-related diseases. This review article concludes that among all spices used in Indian kitchens, turmeric, ginger, garlic, cinnamon, pepper, and cloves are particularly beneficial for the management of various diseases. Fruits and vegetables contain some important phytochemicals that exert antioxidant, antidiabetic, anticancer, cardioprotective, immunomodulatory, anti-inflammatory, and antibacterial effects in the human system. Thus, incorporating a variety of these flavourful plant-based ingredients into the diet regularly is an excellent way to obtain their health-promoting phytochemicals and support overall well-being. Moreover, fruits, vegetables, herbs, and spices are feasible, natural, and healthy approaches to fulfilling nutritional needs and preventing lifestyle-related diseases.

Acknowledgement

We highly acknowledge the Department of Science and Technology for providing financial support to DS under the DST-Inspire fellowship (IF200174), Government of India.

Conflict of interest

The authors declare that there are no competing interests.

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