



Pertinence of nutriments for a stalwart body

Rajwinder Kaur¹ · Ankita Sood¹ · Muskan Kanotra¹ · Sandeep Arora¹ · Vetriselvan Subramaniyan² · Saurabh Bhatia^{3,4} · Ahmed Al-Harrasi⁴ · Lotfi Aleya⁵ · Tapan Behl¹

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Abstract

Nutrition plays a significant role in the prevention and treatment of common diseases. Some superb dietary choices such as functional foods and nutriments can surely help fight against certain diseases and provide various advantages to an individual's health. Plants have been regarded as a primary source of highly effective conventional drugs leading to the development of potential novel agents, which may boost the treatment. Growing demand for functional foods acts as an aid for the producers to expand in agriculture and pave the way for innovation and research by the nutraceutical industry. The given review highlights how various functional foods such as tomatoes, chocolates, garlic and flaxseed are currently being defined, their sources, benefit in treating various ailments and the challenges with their use.

Keywords Functional foods · Nutriments · Antioxidants · Phytochemicals · Nutraceuticals

Introduction

The definition of functional foods is not limited; hence, there is no universally accepted definition for it. The notion of the application of functional foods goes back to the 1980s in Japan. Due to the elevating costs in medical management, the Ministry of Health and Welfare commenced proper regulations to use specific foods that provide medicinal benefits and boost patients' health suffering from various ailments (Arai 1996). Functional foods have been defined as whole,

fortified, enhanced and enriched food by the American Dietetic Association. They are considered part of the diet on an unvarying basis at efficacious levels (Thomson et al. 1999). In 1999, the Foundation for Innovation in Medicine used the term “nutraceuticals” for the first time, and this term can be used interchangeably with functional foods. Whole foods were differentiated from the isolated components in 1990 by Zeisel, and he had a different definition for nutraceuticals. According to him, nutraceuticals are those diet supplements that deliver a concentrated form of a presumed bioactive agent from a food, presented in a non-food matrix, in dosages that exceed those that could be obtained from regular food (Zeisel 1999).

A majority of the functional foods have multiple therapeutic benefits and have been claimed to have physiological benefits or provide protection against various diseases, as shown in Fig. 1 (Das et al. 2012). Besides, they act as cardiovascular agents, anti-obese agents, anti-diabetic agents, anti-cancer agents, immuno-boosters, substances that manage chronic inflammatory disorders and formulations to cure degenerative diseases (Rajasekaran et al. 2008).

Nutriment also refer to natural functional/medical foods or bioactive phytochemicals with health-promoting, disease-preventing or medicinal properties. These nutriment, in general, contain vitamins, lipids, proteins, carbohydrates, minerals or other necessary nutrients, depending on their emphases (Whitman 2001).

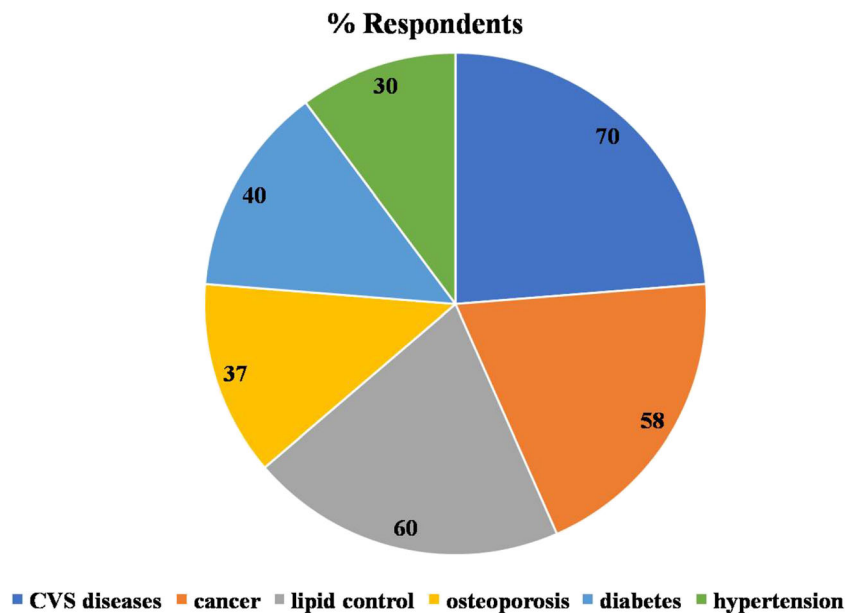
Rajwinder Kaur, Ankita Sood, Muskan Kanotra and Tapan Behl contributed equally to this work.

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✉ Tapan Behl
tapanbehl31@gmail.com

- ¹ Chitkara College of Pharmacy, Chitkara University, Rajpura, Punjab, India
- ² Faculty of Medicine, Bioscience and Nursing, MAHSA University, Jenjarom, Malaysia
- ³ Amity Institute of Pharmacy, Amity University, Gurugram, Haryana, India
- ⁴ Natural & Medical Sciences Research Centre, University of Nizwa, Birkat Al Mauz, Nizwa, Oman
- ⁵ Chrono-Environment Laboratory, UMR CNRS 6249, Bourgogne Franche-Comté University, Besançon, France

Fig. 1 Pie chart demonstrating therapeutic benefits provided by the nutriment



Functional food

Significance of functional food

There are positive effects on the health and well-being of humans due to the use of the traditional Mediterranean diet, which can pave the way for designing functional foods. Vegetables, fruits and nuts are a rich source of bioactive compounds like phenols, flavonoids, isoflavonoids, phytosterols and phytic acid. Fish is a rich source of polyunsaturated fatty acids, responsible for regulating haemostatic factors, protecting against cardiac arrhythmias, cancer and hypertension, and plays a vital role in maintaining neural functions and preventing certain psychiatric disorders (Ortega 2006).

An integral component of the Mediterranean diet, olive oil, has health benefits, including reducing the risk of coronary heart disease, preventing various types of carcinomas and modifying the immune and inflammatory responses. Olive oil is rich in monounsaturated fatty acids and is a good source of phytochemicals, such as polyphenolic compounds, squalene and alpha-tocopherol (Pagliai et al. 2018).

Classification of functional food

Various active ingredients regulating physiological functions of the body are obtained from plant or animal sources and are beneficial in preventing ailments and providing a relevant cure. However, necessary medical documentation of their significance in healthcare is limited. Many plant-based foods have a strong potential that is not currently being approved for clinical use, but there is a piece of evidence for their health

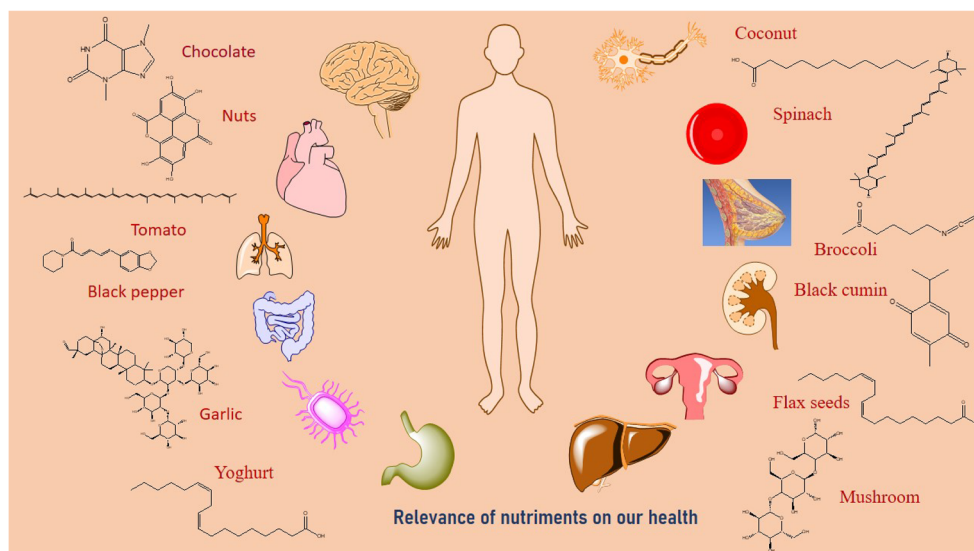
benefits (Khramtsov et al. 2017). The functional foods can be classified into flax seeds, chocolate, broccoli, tomato and many more having excellent therapeutic actions on the various organ systems of the body as depicted in Fig. 2. Each nutriment has its value and pharmacological actions, as mentioned in Table 2.

Flaxseeds

Flaxseeds, also known as linseeds, which are dried and ripe, are obtained from *Linum usitatissimum*. It is cultivated commonly in most of the world, and Canada is the largest cultivator. Lipid profile and blood pressure can be improved due to the administration of flax seeds, which helps treat hypertension and hyperlipidaemia (Haghighatsiar et al. 2019). Flaxseeds are a rich source of omega-3 fatty acid, alpha-linolenic acid and fibres (Parikh et al. 2019). Coronary heart disease is a major cause of death worldwide. The composition of flaxseed includes a high concentration of lignans such as secoisolariciresinol diglucoside, fibre and α -linolenic acid, which provide cardiovascular protection. A decrease in serum cholesterol levels decreases the incidence of cardiovascular disease. Flaxseeds also have hypoglycaemic effects, which can help in the prevention of diabetes mellitus. Flaxseeds have high arginine content, due to which they exhibit anti-hypertensive properties and maintain blood pressure. Besides, flaxseeds also possess antioxidant and anti-inflammatory properties.

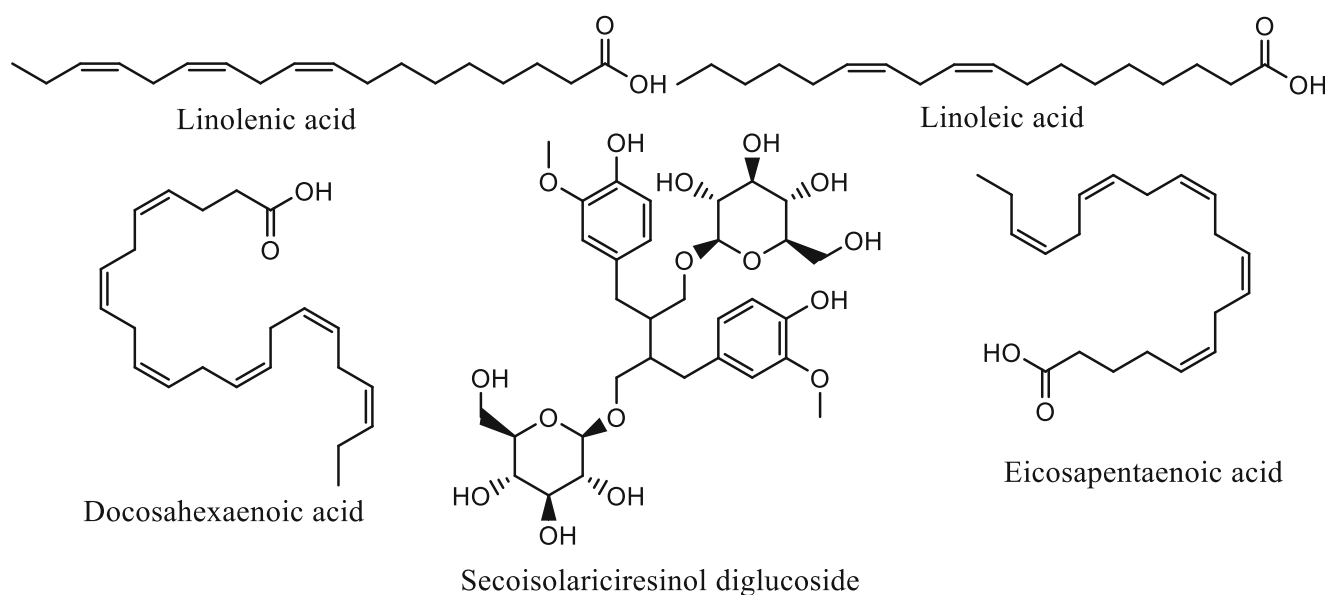
Flaxseeds show cholesterol-lowering properties hence reducing the levels of LDL and total serum cholesterol (Haghighatsiar et al. 2019). They can be consumed in whole flaxseed, ground flaxseed, flaxseed oil and partially defatted flaxseed. They can also be consumed in the form of flax milk

Fig. 2 Action of essential nutriments on various organ systems of the body including cardiovascular, respiratory, nervous, gastrointestinal, hepatic and reproductive systems



which is cholesterol and lactose-free, and provides health benefits and suitable for people who are allergic to soy, gluten and nuts. It can be incorporated into other food items, including muffins, biscuits, buns, rolls and pasta, to enhance the flavour. The presence of

phytic acids, linatine and cyanogenic glycosides in flax-seeds can alter the bioavailability of various essential nutrients. They are of significance to breast cancer patients as it reduces tumor growth and mortality (Chishty and Bissu 2016).



Chemical constituents of flax seeds

The chemical structure of flaxseed lignans is similar to mammalian oestrogen and is responsible for oestrogen-like effects. Besides being effective in breast cancer, flaxseeds are also beneficial in prostate, lung, ovarian and endometrium cancer due to the presence of α -linolenic acid and

secoisolariciresinol diglucoside. They are protective in cancer because they inhibit cellular proliferation, angiogenesis, metastasis and inflammation (Kajla et al. 2015). Omega-3 fatty acids docosahexaenoic acid and eicosapentaenoic acid have an essential role in brain development and memory. Flaxseeds

also have a beneficial role in the management of menopausal symptoms and prevent the severity of hot flashes. However, it is advised to be taken cautiously during pregnancy and lactation (Goyal et al. 2014). Tartrate-resistant acid phosphatase, a bone resorption marker, was decreased in postmenopausal women who were administered flaxseed. Administration of flax oil can prevent the incidence of alcoholic liver disease by reducing the presence of Proteobacteria and Porphyromonadaceae (Parikh et al. 2019). Flaxseeds are known to be beneficial in a condition called PCOS (polycystic ovarian syndrome), an endocrine disorder of women. Flaxseeds in combination with lifestyle modification were able to reduce weight and insulin concentration and improved menstrual cycle (Haidari et al. 2020). Supplementations of flax seeds result in a remarkable deduction in ovarian volume and the number of follicles in polycystic ovaries. Frequency improvement of a menstrual cycle is observed. Not only this, but it does not produce changes in body weight, body sugar and also hirsutism. These positive outcomes of FSP recorded could be due to reduction in testosterone, oestrogen, LH and insulin levels contributing to follicular maturation and the anti-inflammatory actions to the reduction in ovarian volume. Flax seeds can be used as an alternative source for future drug development for PCOS by observing the continuous improvement in ovarian function and menstrual cycle (Nowak et al. 2007). The clinical status of flaxseeds in PCOS treatment is mentioned in Table 4.

Tomato

Tomatoes are the edible berry of the plant *Solanum lycopersicum*. Tomatoes and their supplements are used to benefit the chemoprevention of growth as they are a significant dietary source of carotenoid lycopene (Fan et al. 2018; Story et al. 2010). Lycopene is a non-provitamin A, which is an intoxicating antioxidant. Giovannucci et al. conducted 72 epidemiologic studies. Fifty-seven studies indicated a reverse connection between intake of tomato or lycopene concentration in plasma and the possibility of developing carcinoma at a particular site of the body. High tomato consumption and lycopene level in blood were not reflected in the studies. There was no unique relationship between tomato consumption and cancer risk. According to the data, people affected with prostate, lung and belly carcinoma received the maximum benefits. Patients suffering from carcinomas of the pancreas, colon and rectum, oesophagus, oral cavity, breast and cervix also received benefits and advantages using tomato as a nutriment (Giovannucci 1999). The red colour of tomato is due to lycopene, and it constitutes a major part of the diet of North Americans and Europeans. Tomato has potential health benefits. β -Carotene, another carotenoid present in tomato, is known to reduce cancer risk, especially in

cancers in which tobacco is the causative agent (Wei and Giovannucci 2012). In an Italian case study, more than seven servings of tomato consumption compared to less than two servings taken per week proved more beneficial and had a 50% risk reduction. Gastric cancer risk was found to decrease with high serum concentrations of lycopene. By consuming tomatoes, the risk of developing malignancies and polyps of the colon and rectum was found to decrease (Clinton 1998).

Garlic

Allium sativum is a perennial plant containing compounds sulfur and selenium. Garlic shows antibacterial,

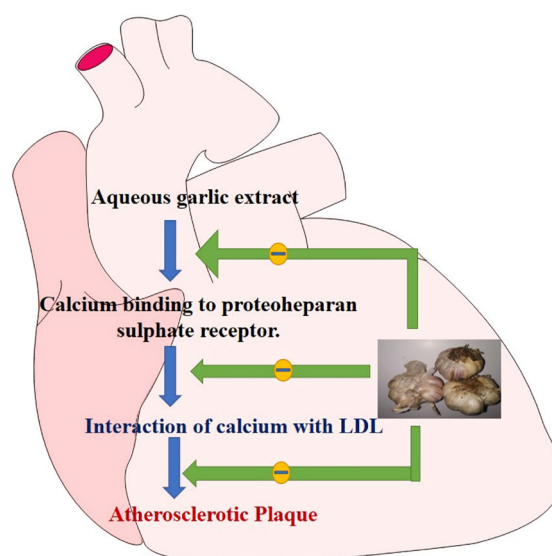
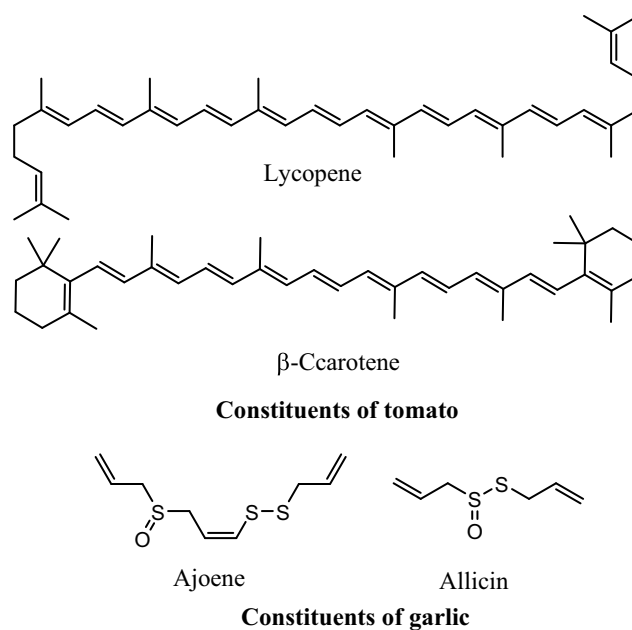


Fig. 3 Role of garlic in inhibition of the atherosclerotic plaque and reduction in the risk of developing cardiovascular disease

antitumor, antiplatelet, anti-hypertensive and antiasthmatic effects. The prevalence of cancer is decreased due to the consumption of onion and garlic (Suleria et al. 2015). A substantial decrease in gastrointestinal and prostate cancers has been observed with regular and adequate consumption of garlic (Bayan et al. 2014). Garlic possesses an anti-cancer effect due to the presence of selenium. Thiosulfates are responsible for enzyme inhibition in cancerous cells. Garlic is responsible for increasing glutathione peroxidase and inhibiting the enzyme HMG-CoA reductase and hence inactivating nitrosamines. Conversion of nitrate to nitrite can be inhibited in case of stomach cancers. N-nitrosation is also inhibited due to the formation of S-nitrosothiols or thionitrites and nitric oxide. Allicin is responsible for carrying out apoptosis of cancerous cells and inhibiting their growth. Allicin also triggers the activation of caspases-3, -8 and -9 and cleavage of poly (ADP-ribose) polymerase. The proliferation of cancerous cells of the mammary gland, colon and endometrium is also inhibited by allicin. Ajoene, another organosulfur compound present in garlic, helps in the prevention of skin cancer (Block 2004). Garlic possesses antibacterial activity against *E. coli*, *H. pylori* and antifungal activity against *Candida albicans*. Allicin also shows antipara-

sitic activity against *Entamoeba histolytica* and giardia (Pise et al. 2009). Garlic shows anticoagulation property by blocking the binding of fibrinogen to platelets. Garlic helps in the relaxation of vascular smooth muscles. Garlic shows anti-hyperlipidemic activity by decreasing the formation of fatty streaks. Figure 3 depicts the action of garlic in preventing the formation of atherosclerotic plaque. Aqueous garlic extract inhibits calcium binding to proteoglycan sulphate receptor leading to inhibition of calcium interaction with LDL. The enzyme HMG-CoA reductase is affected, which inhibits the biosynthesis of cholesterol. Garlic shows antioxidant activity by inhibiting nitric oxide production by cytokine-induced NO synthase. T cell functions are regulated by allicin which helps in treating chronic inflammatory diseases (Block 2004). Consumption of garlic also decreases the risk of having nasopharyngeal, colon and endometrial carcinomas (Takezaki et al. 1999). The lipid-lowering effects of garlic have been observed, and it is known to reduce cholesterol levels in the body. Garlic also has other protective effects such as reduction in blood pressure, inhibiting platelet formation in cardiovascular diseases and increased blood flow in the arteries (Stevenson et al. 2000).

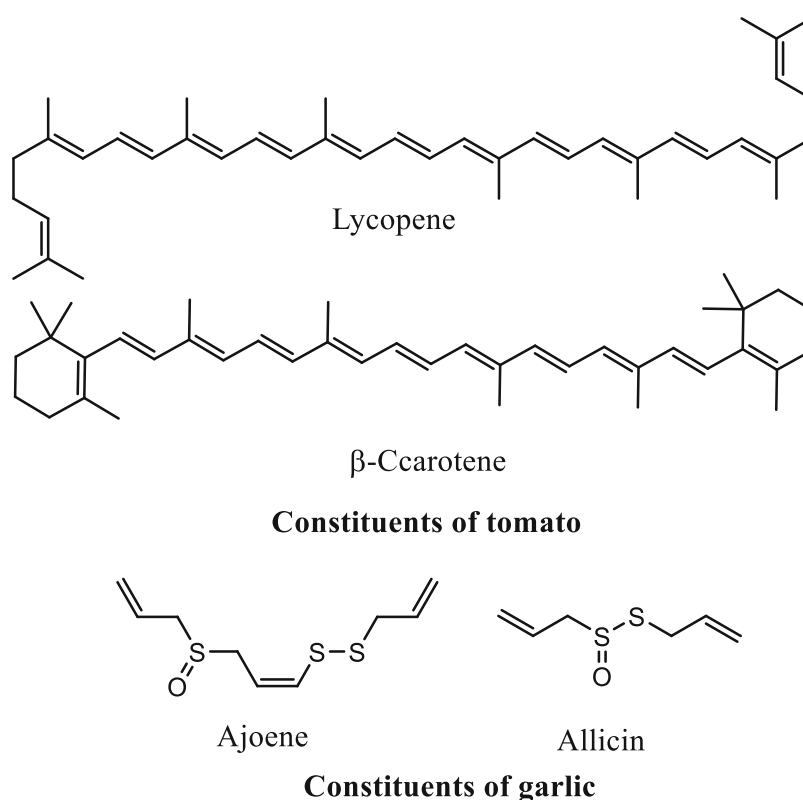
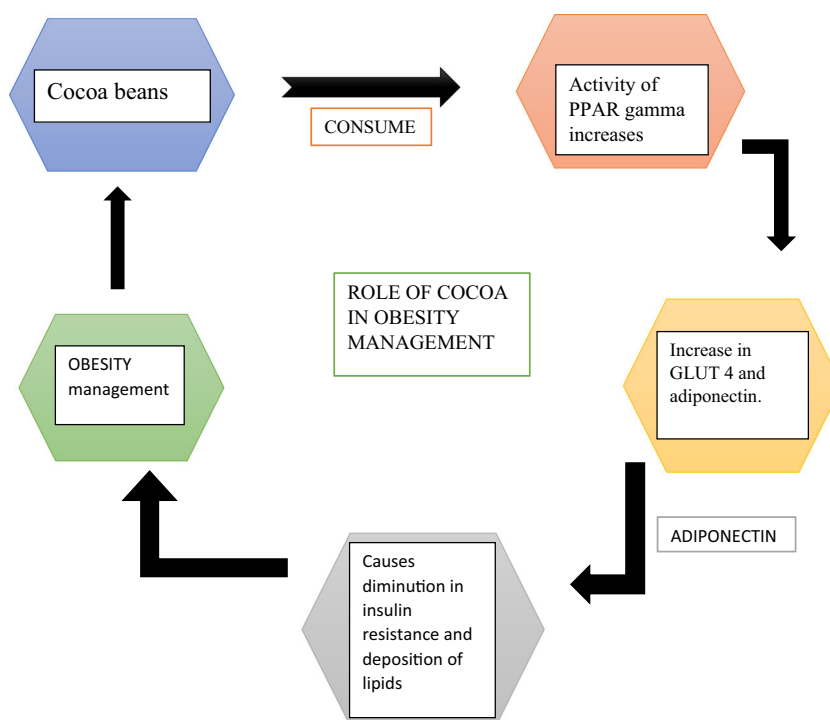


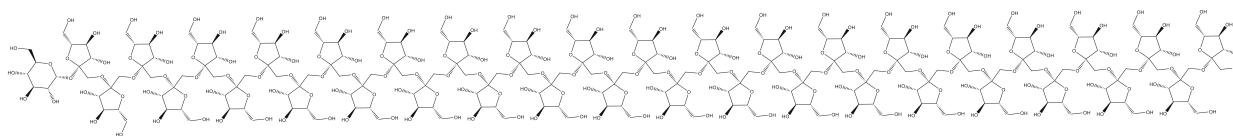
Fig. 4 Protective role of cocoa in obesity



Yoghurt

Consumption of dairy products such as yoghurt can improve both physical and mental health and improve nutrition-related disorders (Park 2009). Yoghurt consists of nutrients and bio-active components. It is a rich source of proteins, α S1-casein, α S2-casein, β -casein, κ -casein, β -lactoglobulin, linoleic acid, inulin and fat, and vitamins such as A, D, B2, B5 and B12, and minerals such as calcium, phosphorus, magnesium, iodine, potassium and zinc. The presence of proteins helps in better

digestion with a positive effect on gut microbiota. Yoghurt is beneficial in cardiometabolic diseases such as obesity, diabetes and hypertension. Bone health is also enhanced, and the risk of cancers is reduced (Astrup 2014). Consumption of dairy products such as milk and yoghurt reduces coronary artery disease and cardiovascular disease incidence. Yoghurt can improve symptoms of various metabolic disorders, including obesity, diabetes and hypertension. Yoghurt also possesses probiotic action (Guiné and De Lemos 2020).



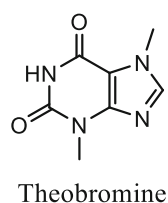
Chocolate

Chocolate is obtained from roasted seeds of *Theobroma cacao* L. Coconas and chocolates are a rich source of flavonoids and polyphenols (<https://theconversation.com/a-brief-history-of-chocolate-and-some-of-its-surprising-health-benefits-142692>)

They possess antioxidant property due to the presence of catechin, procyanidins and theobromine. LDL oxidation is

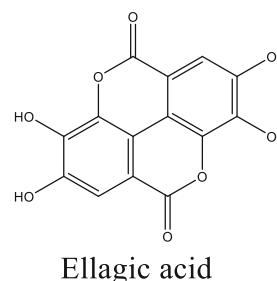
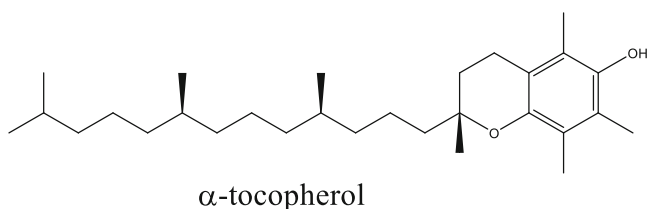
inhibited due to the scavenging of radicals, and the risk of thrombosis is reduced (Smith 2013). Chocolates also exhibit lipoprotein-binding antioxidant property thereby reducing the risk of cardiovascular diseases (Wan et al. 2001). The vascular environment can also be improved due to adequate consumption of cocoa (Erdman et al. 2008). Cocoa can also enhance physical and mental functions. The constituents of cocoa include cocoa butter, minerals, methylxanthines and polyphenols. Neuroprotective and neuromodulatory actions occur due

to the presence of flavonoids that promote neurogenesis and improve neurons' function. The flow of blood to the brain and sensory systems also increases. Cognition is enhanced, insulin resistance is improved and there is an improvement in anti-inflammatory properties. Tryptophan is converted into serotonin which is helpful in the prevention of depression (Mestry et al. 2016). Dark chocolate has a beneficiary role in management of obesity by reducing body weight and body fat. It consists of cocoa flavanols which are known to possess antioxidant properties (Halib et al. 2020). Polyphenols present in dark chocolate decrease fat absorption and fat synthesis. Cocoa aids in glucose and lipid digestion by inhibiting pancreatic enzymes and suppressing early stages of adipogenesis. Dark chocolate reduces cravings due to its intense cocoa flavour (Farhat et al. 2014). Figure 4 depicts the mechanism behind controlling obesity due to consumption of cocoa by attenuating lipid deposition.



Nuts

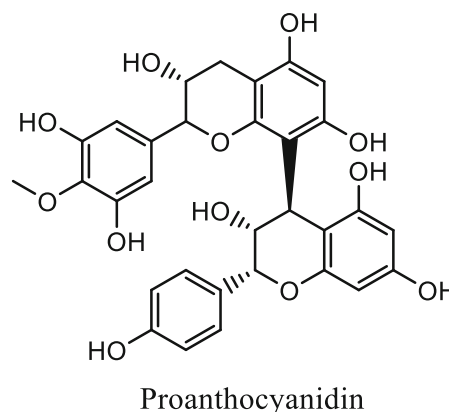
Walnuts are good in reducing cases of cardiovascular diseases. Walnuts are a rich source of polyunsaturated fatty acids, tannins such as ellagic acid and polyphenols. They lower the blood lipid levels (Feldman 2002). Nuts contain 46–76% of fats and also consist of sterols, vitamins, polyphenols, minerals and antioxidants. Walnuts are composed of omega-3 and omega-6 fatty acids. The endothelial function is improved in hypercholesterolemic and diabetic patients. Polyphenols contain antioxidant α -tocopherol, which helps in preventing oxidation and hence protects the heart (Bashan and Bakman 2018).



Constituents of nuts

Cranberries

Vaccinium macrocarpon, also called the American Cranberry, has an amazing history. Cranberry is known to treat urinary tract infections (UTIs) by carrying out urine acidification (<https://www.webmd.com/food-recipes/health-benefits-cranberries>). The other mechanism by which cranberries help in treating UTIs is that they inhibit adhesion of the bacteria *E. coli* to uroepithelial cells due to proanthocyanidins (Blumberg et al. 2013). Cranberries also have anti-adhesion properties for urinary pathogens and antioxidant properties (Hisano et al. 2012). The active biological compounds present in the cranberries include xyloglucan oligosaccharides such as arabinoxyloglucan oligosaccharides and pectic oligosaccharides (Gardana et al. 2020). Cranberries maintain gut health and oral health. Cranberries are also used in the treatment of chronic diseases, including diabetes, high cholesterol and cancer. The fermented cranberries maintain epithelial cell health and lower cholesterol. They also reduce secondary bile levels and hence help in the detoxification process (Coleman and Ferreira 2020).

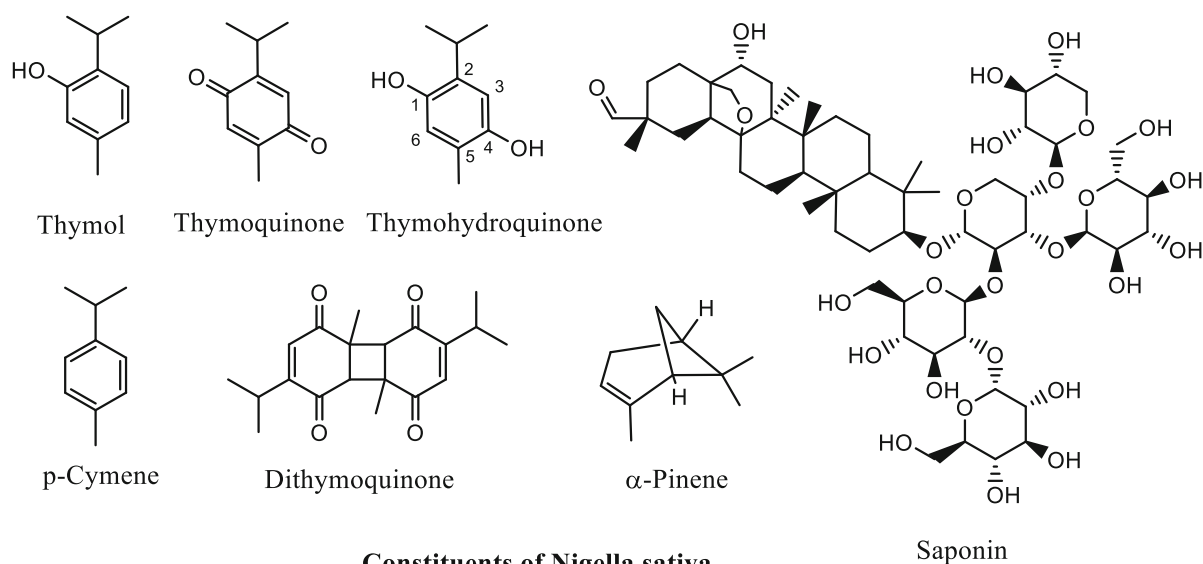


Nigella sativa

Nigella sativa or black cumin is used as a traditional medicine that belongs to the family Ranunculaceae. Its composition includes essential oils, proteins, thymoquinone, alkaloids, thymohydroquinone, dithymoquinone, p-cymene, α -pinene, thymol and saponin. *Nigella sativa* has antioxidant properties.

It balances the production of reactive oxygen species and the defence system of the body. It has been traditionally used to treat various ailments, including disorders of the digestive tract, respiratory tract such as asthma and bronchitis, cardiovascular system, immune system, renal disorders and liver disorders (Rahmani and Aly 2015). It is also called a seed of blessing used in treating indigestion, diarrhoea, amenorrhoea and dysmenorrhoea. The oil extracted from the seeds can be used in the treatment of skin disorders as an antiseptic. It is also known to possess antibacterial property against *Staphylococcus aureus* due to the presence of thymoquinone and melanin. *N. sativa* also possesses

anti *H. pylori* action in patients with non-ulcer dyspepsia. It shows antifungal properties against *Candida albicans*. It shows efficacy in the prevention of liver damage caused due to *Schistosoma mansoni* by decreasing the number of worms. A combination of black cumin and praziquantel is efficient in decreasing the ova production by *Schistosoma mansoni*. Black cumin also possesses anti-diabetic, anti-cancer, anti-inflammatory properties, cardiovascular activity, immunomodulatory action, gastro-protective action, nephroprotective action and analgesic activity, and exhibits neuro-pharmacological actions (Rachman and Darmawan 2017; Ahmad et al. 2013)

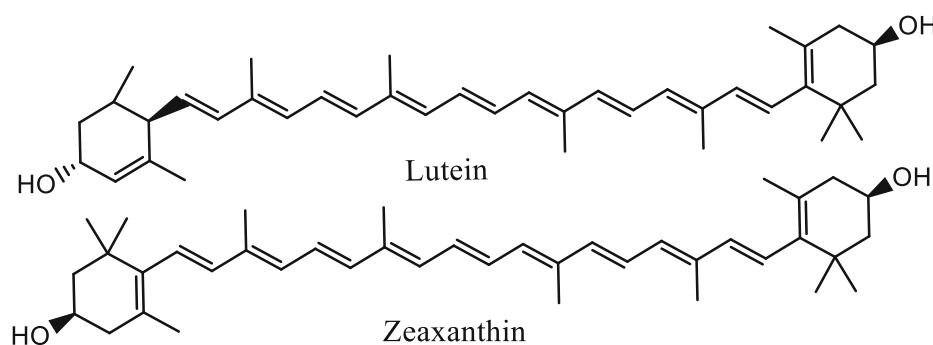


Constituents of *Nigella sativa*

Avocado

Persea americana or avocado, or gator pear, shows magnificent nutritional and medicinal properties. Its composition includes fats; proteins; fibres; vitamins C, E, K, B1, B2, B6 and B9; phosphorus; sodium; magnesium; potassium; zinc; and iron. Due to its low sugar content, it can be consumed by diabetic people as well. Phytochemical constituents present in avocado show anti-cancer properties by activating apoptosis in cancer cell lines. The presence of vitamins A and B prevents carcinogenesis and inflammation. It is regarded as an essential food by American Dietetic Association (Alkhalaf et al. 2019). Avocados are a

rich source of monounsaturated fatty acids, which enhance phytochemical bioavailability. Avocados have a beneficial effect in the management of total cholesterol levels and controlling body weight. Consumption of avocado paves the way for a healthy heart. Avocado is composed of potassium which helps in the management of hypertension. Magnesium present in avocado acts as a cofactor for enzymes necessary for energy metabolism. Lutein and zeaxanthin present in avocado improve eye health. Avocado is also beneficial in the treatment of osteoarthritis and also maintain skin health. Avocados are beneficial in treating cancers of the larynx, pharynx and oral activity (Dreher and Davenport 2013).



Constituents of avocado

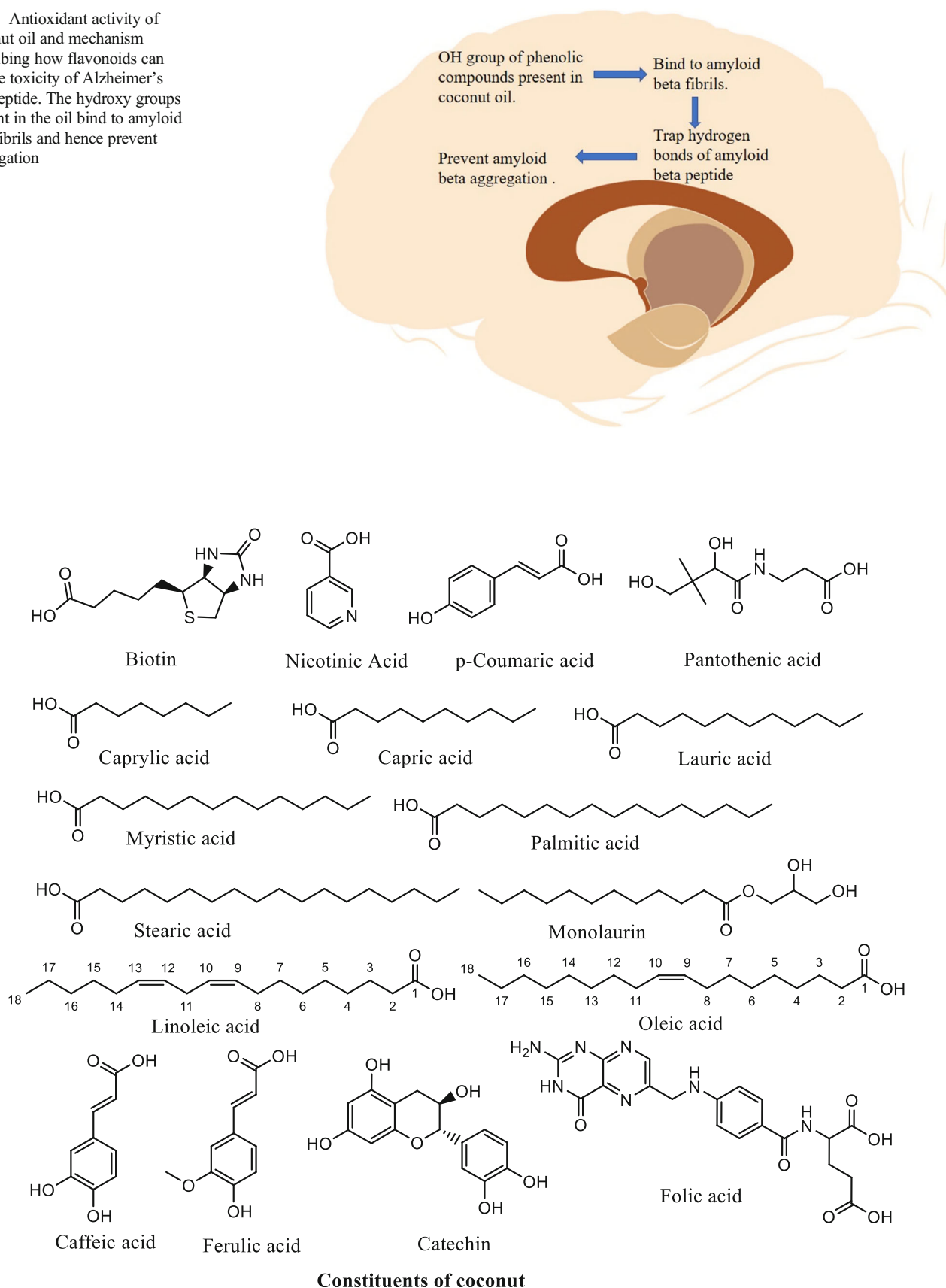
Coconut

Cocos nucifera L. (coconut), belonging to the family Arecaceae, has both nutritional and medicinal properties. Coconut products consist of coconut water, oil, kernels, cake, shell and leaves. Coconut forms an essential part of Indian folk medicine. Coconut water or the liquid endosperm is used as a natural soft drink (Segura-Badilla et al. 2020). Constituents of coconut water include vitamin B, nicotinic acid, pantothenic acid, biotin, sugars, amino acids, vitamin C and folic acid. Coconut can serve as an electrolyte as it contains adequate levels of potassium, sodium, calcium, magnesium and phosphorus ions (Loomba and Varghese 2013). Tender coconut water can reduce blood pressure. It can act as an antidote also as it helps in the elimination of poisons. The generation of free radicals is reduced due to the presence of amino acid L-arginine. Peroxidation of lipids is decreased due to the presence of vitamin C in water (Prades et al. 2012). Various fatty acids are present in coconut, including caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, oleic acid, stearic acid and linoleic acid. Coconut water helps in the protection of the heart due to the presence of potassium in it. The density of total cholesterol, triglycerides, LDL and VLDL increases, and the density of HDL elevates by consumption of coconut oil. Coconut oil also exhibits an antithrombotic effect. The concentration of t-PA (tissue plasminogen activator) antigen is lowered by coconut oil rich in saturated fatty acids. Lauric acid and monolaurin are known to kill bacterial species *Chlamydia pneumoniae*, known for causing atherosclerosis by inducing inflammation resulting in lipoprotein oxidation. L-Arginine is responsible for the hypolipidemic effect, and polyphenols maintain lipid level by inhibiting LDL oxidation, reversing the transport of cholesterol and decreasing absorption of cholesterol in the intestines. Coconut shows an anticholecystitic effect by

treating the calculi in kidneys and urethra. Tender coconut water consists of saline and albumin and is used to treat cholera (DebMandal and Mandal 2011). Medium-chain saturated fatty acids are present in coconut oil, and they are easily absorbed and metabolised by the liver (Fernando et al. 2015). They carry out the destruction of lipid-coated bacteria. Coconut oil has bactericidal activity against *E. coli*, *P. aeruginosa*, *Proteus vulgaris*, etc. Besides, it can be used as a skin moisturiser, atopic dermatitis and an antiseptic. Decoction extracted from the roots of the coconut tree can be used as a gargle or mouthwash. Mouth sores can be treated using coconut flour due to the presence of lauric acid.

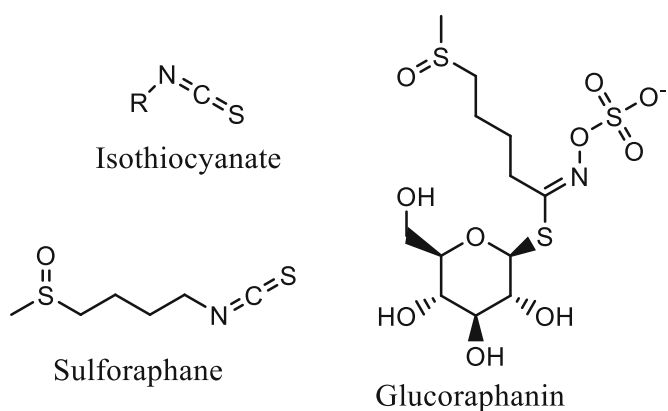
Sucrose monolaurate, a constituent of coconut, has an anti-caries effect. Coconut oil exhibits antiviral property against Epstein-Barr virus, influenza, leukaemia virus, hepatitis virus, etc. Monolaurin shows antifungal activity against *Aspergillus* sp., *Penicillium* sp., *C. Albicans*, etc. Trichomoniasis can be treated using coconut and can inhibit the growth of *Leishmania amazonensis*. Coconut kernel protein has an anti-diabetic property by reversing glycogen levels (DebMandal and Mandal 2011). Coconut oil, water and cream may reduce the risk factors such as cholesterol, blood pressure and blood glucose levels associated with Alzheimer's disease. Coconut can enhance the cognition process, which is beneficial for Alzheimer's patients. The antioxidant property is present due to polyphenols such as ferulic acid, caffeic acid, catechin acid and p-coumaric acid. The hydroxyl group present in polyphenols decrease the toxicity of A β peptide in Alzheimer's. Trans-zeatin, a component of coconut water, exhibits cell-protective action against toxicity induced by A β plaques. Trans-zeatin is also an inhibitor of acetylcholinesterase. Figure 5 depicts the role of flavonoids and phenolic compounds in reducing A β aggregation and help prevent oxidative stress-mediated Alzheimer's disease (Fernando et al. 2015).

Fig. 5 Antioxidant activity of coconut oil and mechanism describing how flavonoids can reduce toxicity of Alzheimer's A β peptide. The hydroxy groups present in the oil bind to amyloid beta fibrils and hence prevent aggregation



Broccoli

Brassica oleracea is a cruciferous vegetable of the mustard family grown from its edible flower buds and stalk. Broccoli is low in calories and a rich source of vitamins and antioxidants (<https://www.medicalnewstoday.com/articles/266765>). Carcinogenesis can be protected via induction of phase 2 detoxification enzymes such as glutathione transferase, epoxide hydrolase and NADPH (<https://www.freshly.com/blog/articles/broccoli-nutrition-and-health-benefits>). Isothiocyanates, present in broccoli, induce phase 2 enzymes. Broccoli sprouts contain increased levels of glucoraphanin and sulforaphane, which are responsible for inducer activity (Fahey et al. 1997). Broccoli sprouts consist of vitamins, carotenoids, minerals and phenolics, and exhibit apoptotic, antibacterial and antioxidant properties. Sprouts possess antiproliferative activity against various carcinomas such as lung carcinoma, hepatocellular carcinoma and colorectal carcinoma. The sprouts show antibacterial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Salmonella typhimurium*. The advantage of using sprouts is that the use of fertilisers and pesticides can be reduced. The sprouts are rich in flavonoids, phenols and vitamin C. The antioxidant activity of broccoli was studied using DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay (Le et al. 2019).

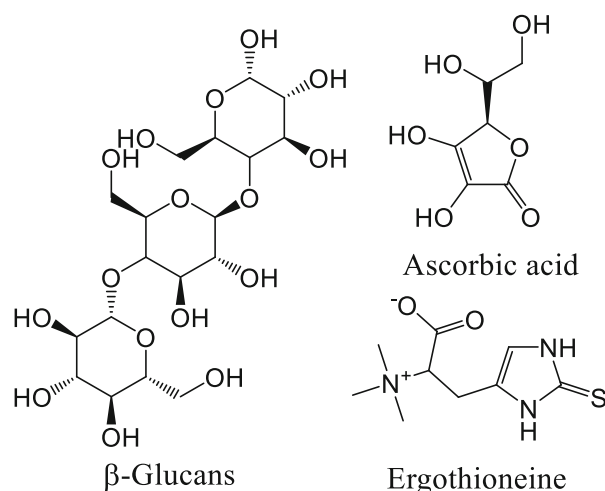


Constituents of broccoli

Mushroom

Agaricus campestris is the standard edible part of the fundus of fields and meadows. Mushrooms possess organoleptic properties, medicinal values and a high amount of proteins, fibres, vitamins and minerals. Mushrooms consist of various molecules, including polysaccharides, flavonoids, phenolics, carotenoids, enzymes, alkaloids, volatile oils and terpenoids (Ma et al. 2018). Edible mushrooms are composed of

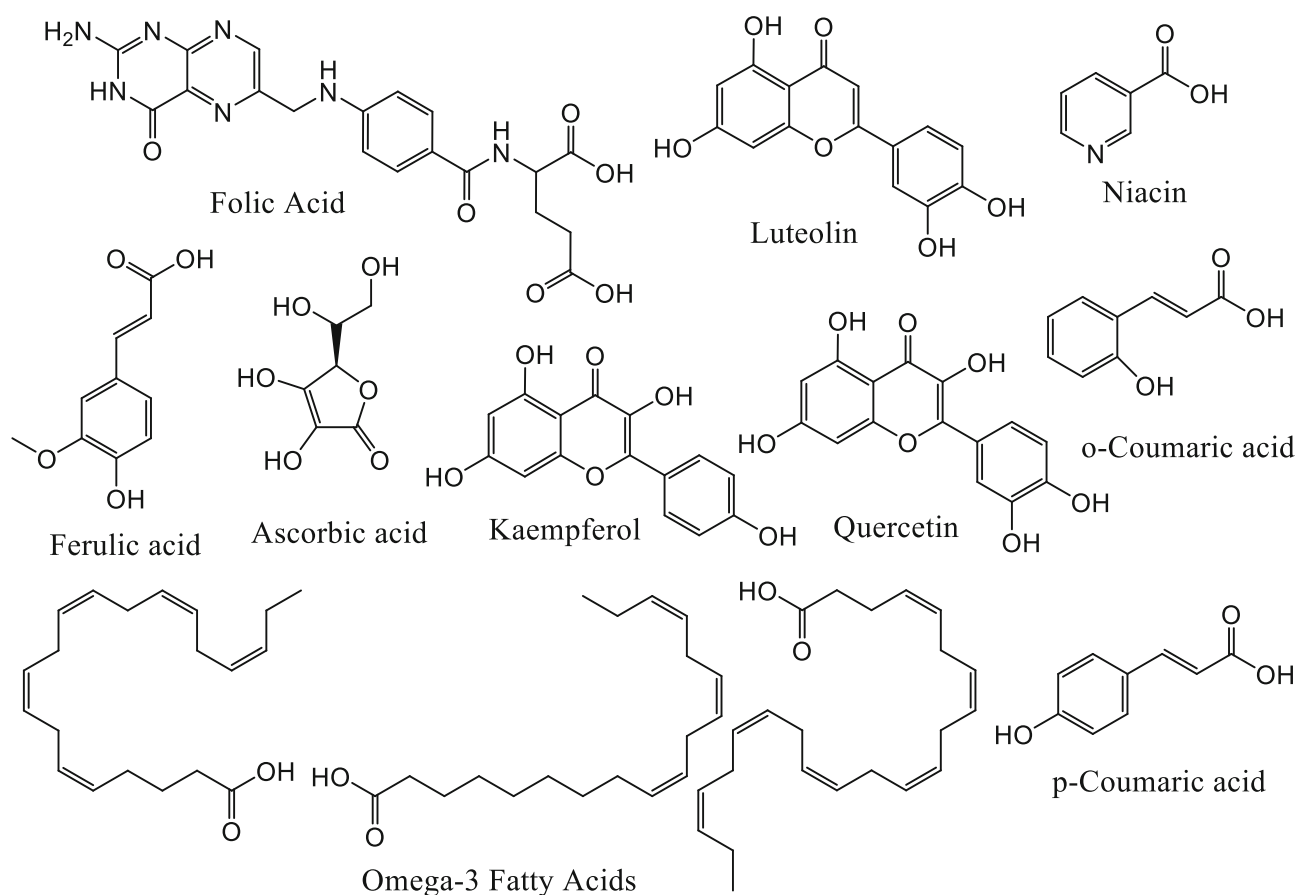
polysaccharide β -glucans, fibres, peptides, glycoproteins, ascorbic acid etc. Vitamins D2 and B1, iron, selenium and ergothioneine are present in mushrooms. Biologically active constituents are present in fruiting bodies, mycelium and broth of mushrooms. They are also used as a traditional medicine in various countries, including Japan, Russia, Korea and China. They also exhibit various pharmacological actions, including antiviral, antibacterial, antifungal, anti-inflammatory, anti-tumor, hepatoprotective, anti-diabetic, hypolipidemic, anti-thrombotic actions (Valverde et al. 2015). Oyster mushrooms consist of polysaccharides that possess anti-hyperlipidemic activity. Proteoglycans present in *Agaricus blazei* show immunomodulatory and anti-tumor activity. Polysaccharides present in *Agaricus bisporus* show activity against breast cancer cells (Cheung 2013). Polysaccharides in *Hericium erinaceus* exhibit anti-tumor, anti-carcinogenic and antioxidant activities. Lectins or the non-immune proteins have antiproliferative, anti-tumor and immunomodulatory activities. Terpenes or volatile unsaturated hydrocarbons show anti-inflammatory activities. The terpenoids isolated consisted of monoterpenes, sesquiterpenoids, flammulinol, flammulinolides and triterpenoids. These terpenes have a great potential in developing drugs for Alzheimer's disease. Mushrooms also have antioxidant properties as they reduce oxidative damage in human beings. Selenium and zinc are responsible for antioxidant activity. Mushrooms are consumed in dietary supplements, nutraceuticals and medicine, referred to as mushroom pharmaceuticals (Üstün et al. 2018). The major bioactive component of mushroom is β -glucans. Mushrooms are also a source of prebiotics that alter gastrointestinal tract microbiota activity, providing health benefits to human beings (Friedman 2016).



Constituents of mushroom

Spinach

Spinacia oleracea (spinach) belongs to the family Chenopodiaceae. It is a rich source of minerals such as iron, copper, zinc, phosphorus, selenium, niacin, folic acid, ascorbic acid, β -carotene, lutein, flavonoids and omega-3-fatty acids. The presence of tannins, alkaloids, flavonoids, steroids, glycosides and terpenoids impart therapeutic properties to spinach. Spinach is also referred to as a natural anti-ageing wonder. Spinach is a scavenger of reactive oxygen species and helps in the prevention of oxidative damage. Besides, it is also a rich source of vitamins A, C, E, K, B2 and B6 (<https://www.medlife.com/blog/15-reasons-why-spinach-called-superfood/>). The fatty content in spinach is absent to be consumed easily by obese and diabetic people. Chlorophyll content present in spinach helps in the digestion process. Spinach also has various medicinal properties such as cooling, emollient, diuretic and antipyretic action. Besides, it is used in treating renal calculi, sore throat, joint pain, ringworm scabies and vomiting ([\[vitamins/ai/ingredientmono-365/spinach\]\(#\)\). Flavonoids such as kaempferol, quercetin and luteolin show antidiabetic properties. Spinach provides a hypoglycaemic effect at a dose of 200 and 400 mg/kg. Anti-oxidative and anti-inflammatory properties help in ulcer healing. Glycosides such as coumarins, steroids and flavonoids provide laxative, anti-oxidative and anti-inflammatory properties. Traditionally, spinach has been used for treating joint pains, osteoarthritis and rheumatoid arthritis. Locomotion and balancing activity is improved. Spinach reduces dopamine levels and AchE activities and increases gamma-aminobutyric acid \(GABA\) levels, which help in anti-schizophrenic activity. Antibacterial activity occurs due to polyphenols para-coumaric acid, ferulic acid and ortho-coumaric acid. Antibacterial activity against gram-negative bacteria is more as compared to gram-positive bacteria. Spinach also possesses anti-cancer activity and is used in treating various forms of cancers such as ovarian, prostate and lung cancer \(Roughani and Miri 2019\).](https://www.webmd.com/</p>
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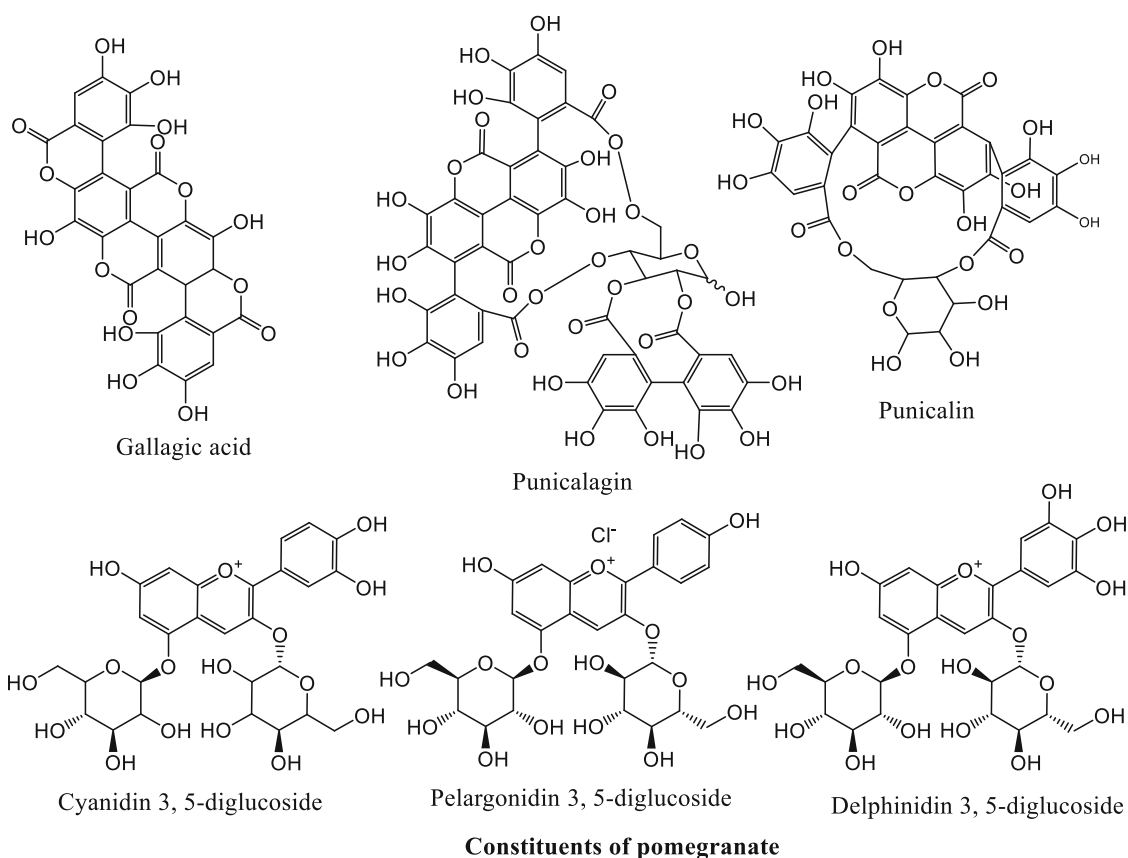


Constituents of spinach

Pomegranate

Punica granatum (pomegranate) is a native fruit of the Middle East. Clinical trials have shown the efficacy of pomegranate against diabetes, relief of menopausal symptoms, hormonal balance, cardiovascular disease and prostate cancer (Kandylis and Kokkinomagoulos 2020). High polyphenolic content such as punicalagin, punicalin, gallic acid and ellagic acid contributes towards its antioxidant activity. Pomegranate is used as an anti-inflammatory, antibacterial, antiviral and antifungal agent. Pomegranate consists of chemical armoures such as anthocyanins and hydrolysable tannins, punicalagin, punicalin, gallic acid and ellagic acid. Anthocyanins and hydrolysable tannins are present in a significant proportion. Hydrolysable tannins attributed towards an antioxidant activity are measured by Trolox equivalent antioxidant capacity and ascorbic acid equivalent antioxidant capacity (Zarfeshany et al. 2014). The major anthocyanins in

pomegranate are delphinidin 3, 5-diglucoside, cyanidin 3,5-diglucoside, pelargonidin 3,5-diglucoside, etc. Peel extracts show more antioxidant activity than the juice and seed extracts, which helped prevent lipid peroxidation. High polyphenolic content attributes to high antioxidant activity. The fruit is beneficial in preventing various types of cancers such as breast, colon, skin, cervical and lung cancers. It promotes cardiovascular health by atherosclerosis prevention and managing hyperlipidaemia. Antiviral components extracted from pomegranate when bound to corn starch lead to the development of a topical microbicide, which, when applied topically to the vagina, can inhibit the binding of HIV particles to cell receptors and, hence, prevent infection. The extract obtained from a pomegranate can inhibit the influenza virus, block its replication and inhibit RBCs' aggregation and provide virucidal activity. Punicalagin is responsible for providing antiviral activity (Johanningsmeier and Harris 2011).



Coriander

Coriandrum sativum L. (coriander) is a part of the family Apiaceae. It has various medicinal properties and has been traditionally used as folk medicine. Coriander is a rich source

of lipids such as petroselinic acid and essential oils such as linalool (Jeet et al. 2020). The most extensively used constituents are the seeds and pericarp, which are composed of essential oils and fatty oils. The oil is a rich source of petroselinic acid. Glycolipids such as acylated steryl glucoside, steryl glucoside

Table 1 Percentage of essential oils in coriander

S. no.	Content of essential oils of coriander	Composition of essential oils of coriander (%)
1.	Linalool	37.7
2.	Geranyl acetate	17.6
3.	Gamma-terpinene	14.4
4.	Beta-pinene	1.82
5.	m-Cymene	1.27
6.	Citronellal	1.96
7.	Citronellol	1.31
8.	Citral	1.36
9.	Geraniol	1.87
10.	Citronellyl acetate	1.36
11.	Alpha-cedrene	3.87
12.	Alpha-farnesene	1.22
13.	β -Sesquiphell-andrene	1.56

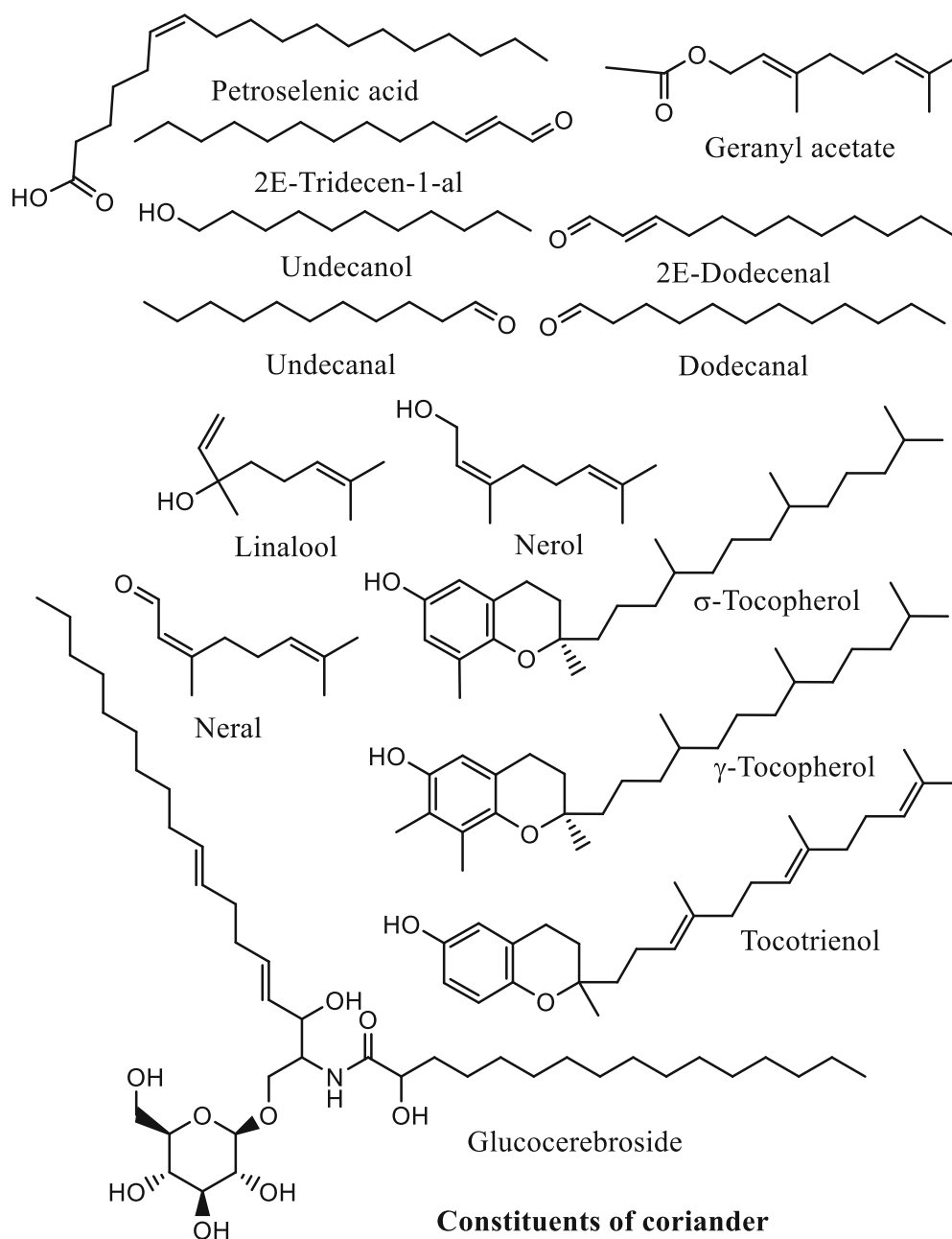
and glucocerebroside are present in a significant quantity in seed oil. Coriander oil is an excellent source of tocopherols such as δ -tocopherol and α -tocopherol. Tocotrienols such as γ -tocotrienol, δ -tocotrienol and α -tocotrienol constitute the seed oil. Glucose is the only sugar detected in coriander (Bhat et al. 2014). Essential oils are a source of bioactive. Table 1 represents the various essential oils and their composition (%) present in coriander. The immature coriander fruits consist of geranyl acetate, linalool, nerol, neral and cis-dihydronerol. The leaves consist of essential oil, flavonoids, phenolic acids and polyphenols. Aldehydes and alcohols are the major constituents of essential oils present in leaves. The main components of a leaf are 2E-tridecen-1-ol, 2E-dodecenal, dodecanol, undecanol, undecanal and alkanes. Coriander leaves are used in treating coughs, chest pains and bladder problems. Coriander fruits are used to treat inflammation, bronchitis, cough,

Table 2 Various nutriment and their pharmacological actions

S. no.	Nutrient	Health benefits	References
1.	Flax seeds	<ul style="list-style-type: none"> • Reduces cardiovascular diseases • Decreases cholesterol level • Prevents diabetes mellitus • Helps to maintain blood pressure • Helps in reducing tumor growth 	Parikh et al. 2019
2.	Tomato	<ul style="list-style-type: none"> • Reduces the risk of prostate, lung and belly carcinoma 	Giovannucci 1999
3.	Garlic	<ul style="list-style-type: none"> • Reduces total and LDL cholesterol • Inhibits growth of cancerous cells • Prevents skin cancer • Reduces blood pressure 	Takezaki et al. 1999
4.	Yoghurt	<ul style="list-style-type: none"> • Inhibits platelet formation in cardiovascular diseases and increased blood flow in the arteries • Reduces symptoms of hypertension and obesity • Good for gut health 	Guiné and De Lemos 2020
5.	Chocolate	<ul style="list-style-type: none"> • Prevents depression, enhances physical and mental functions • Promotes neurogenesis and improves the function of neurons 	Erdman et al. 2008
6.	Nuts	<ul style="list-style-type: none"> • Improves symptoms in hypercholesterolemic and diabetic patients. 	Bashan and Bakman 2018
7.	Cranberries	<ul style="list-style-type: none"> • Prevention of urinary tract infections • Maintains the gut health and oral health • Maintains epithelial cell health and lowers cholesterol 	Coleman and Ferreira 2020
8.	Black cumin	<ul style="list-style-type: none"> • Treats bacterial and fungal infections • Treats indigestion, diarrhoea, amenorrhoea and dysmenorrhoea • It also acts as an antiseptic 	Ahmad et al. 2013
9.	Avocado	<ul style="list-style-type: none"> • Prevents carcinogenesis and inflammation of osteoarthritis • Maintains skin health. 	Dreher and Davenport 2013
10.	<i>Cocus nucifera</i>	<ul style="list-style-type: none"> • Prevents aggregation of amyloid beta-peptide • Cures obesity 	Fernando et al. 2015
11.	Broccoli	<ul style="list-style-type: none"> • Prevents cancer, possesses antiproliferative activity against various carcinomas such as lung carcinoma, hepatocellular carcinoma and colorectal carcinoma. 	Le et al. 2019
12.	Mushroom	<ul style="list-style-type: none"> • Antitumor, immunomodulating and hepatoprotective action • Alters the activity of gastrointestinal tract microbiota providing health benefits to human beings 	Friedman 2016
13.	<i>Spinacia oleracea</i>	<ul style="list-style-type: none"> • Reduces risk of age-related macular degeneration • It also has medicinal properties such as cooling, emollient, diuretic and antipyretic action 	Roughani and Miri 2019
14.	Pomegranate	<ul style="list-style-type: none"> • Reduces diabetes • Helps in prostate growth • Promotes cardiovascular health by atherosclerosis prevention and managing hyperlipidaemia 	Johanningsmeier and Harris 2011

gastrointestinal problems, gout and rheumatism. Coriander is an excellent carminative agent and has antispasmodic actions as well (<https://www.webmd.com/diet/health-benefits-coriander#1>). Essential oil inhibits gram-positive bacteria such as *Staphylococcus aureus*; gram-negative bacteria such as *Escherichia coli*, *Pseudomonas aeruginosa* and *Salmonella typhi*; and fungal species like *Candida albicans*. Flavonoids and polyphenols present in coriander act as antioxidants and are used in the treatment of cancer. Coriander traditionally serves as an anti-diabetic agent. Ethanolic extract of seeds at 200 and 250 mg/kg decreases serum glucose concentration and increases β -cell activity. The seeds show a lipid-lowering effect

by decreasing triglycerides, LDL, VLDL levels and increasing HDL levels. It diminishes the activity of the enzyme HMG-CoA reductase. Coriander has been traditionally used in Iran as an anticonvulsant and anti-depressant. Coriander juice has been known to decrease the mutagenicity of aromatic amines. Coriander is used as a diuretic to treat acute renal failure by enhancing renal salt and water excretion (Sahib et al. 2013). Dodecanal, an antibacterial agent present in coriander leaf, helps fight *Salmonella* (species causing foodborne illness). Miscellaneous uses of coriander include treating mouth ulcers, anaemia, menstrual disorders, eye disorders, smallpox and skin disorders (Beemnet 2020) (Table 2).



Marketed preparations and clinical status of nutriment

Making people more aware of nutraceuticals' benefits can expand the functional food market. Scientific research can be expanded for more effective and safe products. New technologies such as nutrigenomics, imaging techniques and converging technologies can be introduced in the research field (Daliri and Lee 2015). Nutrigenomics is an emerging field which defines the role of nutrition on gene expression involving the science of bioinformatics, molecular biology, nutrition, proteomics and genomics. The concept of nutrigenomics is being followed highly in USA and UK; however, India is still lacking behind and more research into the field is required. Nutrigenomics is being widely studied in heart diseases, cancers, diabetes, male infertility and disorders related to diet (Neeha and Kint 2013). The metabolomics field can be applied in discovering novel biomarkers of food intake as the foods contain various metabolites which enter the body fluids after the digestion process and hence can be detected using targeted and untargeted metabolomics approaches. For example, the putative biomarkers for raspberries are caffeic acid-sulphate and methylepicatechin-sulphate whereas for chocolate are 6-amino-5-(N-methylformylamino)-1-methyluracil, theobromine and 7-methyl-uric acid.

Developments in stem cell biology pave the way for model development in nutrigenomics research (Mathers 2017).

Table 3 depicts the chemical constituents, uses and marketed products available for the various essential nutriment, and Table 4 represents the clinical status of various nutriment undergoing trials whose studies have been completed (<https://www.clinicaltrials.gov/>).

Future perspective

The challenges to achieving feasibility in the field of nutriment are disconcerting. Consumers are increasingly becoming aware of the nutritional benefits of disease prevention. Various studies such as European Commission-funded projects have made it possible to understand essential mechanisms of biologically active compounds present in functional foods. Increasing demand for these nutraceuticals has diversified the field of agriculture and promotes research in these particular areas. The challenges faced by the nutraceutical markets are the regulations of specific countries and health claim substantiation. Increasing health care costs propel the nutraceutical market. Market revenues can be increased by more investment in new technology and applying genetically modified techniques.

Table 3 Marketed preparations of nutriment

S. no.	Name	Chemical constituents	Marketed preparations	Uses
1.	Flaxseeds	Linolenic acid	Healthvit flaxseed oil softgels	<ul style="list-style-type: none"> • Maintains normal blood sugar level • Reduces tenderness in joints • Maintains heart health
2.	Tomato	Lycopene	Healthyhey lycopene capsules	<ul style="list-style-type: none"> • It helps in promoting prostate health • Antioxidant
3.	Garlic	Allicin	Nutra high allicin garlic enteric-coated supplements	<ul style="list-style-type: none"> • Improves cardio, immune and enzyme health
4.	Yoghurt	Linolenic acid	Mother dairy yoghurt	<ul style="list-style-type: none"> • Strengthens immune system • Protects against osteoporosis
5.	Chocolate	Theobromine	Zevic 70% dark Belgian chocolate	<ul style="list-style-type: none"> • Good for concentration • Diabetic patients
6.	Cranberries	Proanthocyanidins	Pure nutrition cranberry plus	<ul style="list-style-type: none"> • Helps to prevent urinary tract infection • Prevents the formation of kidney crystals • Boosts immunity
7.	Black Cumin	Thymoquinone	Mahaved black seed extract capsules	<ul style="list-style-type: none"> • Lowers cholesterol • Improves asthma
8.	Avocado	Lutein and Zeaxanthin	Healthy hey nutrition lutein and zeaxanthin capsules	<ul style="list-style-type: none"> • Improves eye health • Improves skin health
9.	Coconut	Pantothenic acid	Zenith nutrition capsules	<ul style="list-style-type: none"> • Helps build stamina • Stimulates hormones • Promotes good skin health
10.	Broccoli	Sulforaphane	Vitrovia greens powder	<ul style="list-style-type: none"> • Antibacterial • Detox body
11.	Pomegranate	Ellagic acid	Healthvit pomegranate capsules	<ul style="list-style-type: none"> • Aids digestion • Boosts immune health • Promotes healthy skin and hair

Table 4 Description of clinical studies for various essential nutriments

Identifier	Title of the study	Condition/disease	Treatment	Status
NCT02324439	Flaxseed as Maintenance Therapy for Ovarian Cancer Patients in Remission	<ul style="list-style-type: none"> • Epithelial ovarian cancer • Fallopian tube cancer • Primary peritoneal cancer 	Omega nutrition cold-milled flaxseeds	Phase 1
NCT02047123	Nutritional Intervention WithYoghurt and Flaxseed in Women With Profiles Lipi (flaxseed)	Overweight	Raw flaxseed	Not applicable
NCT02014181	Flaxseed Modulates Inflammation and Oxidative Stress in CF	<ul style="list-style-type: none"> • Cystic fibrosis • Oxidative stress • Inflammation 	Finely ground flaxseed powder	Phase 1
NCT03713138	Therapeutic Role of Flax Seed for Poly Cystic Ovary Syndrome	Polycystic ovary syndrome	Flaxseed powder	Not applicable
NCT01698112	Does Flaxseed Supplementation Improve Glycemic Control in Individuals With Pre-diabetes?	Prediabetes	Flaxseed	Not applicable
NCT00937742	The Effect of Processed Tomato Products on CVD Risks (TOMATO)	Cardiovascular disease	Tomato products	Not applicable
NCT02292524	Prostate Biomarkers in Men Consuming Tomato Products	Prostate cancer	Commercially available tomato food product	Not applicable
NCT01665469	Effect of Tomato Extracted Lycopene on Postprandial Oxidation and inflammation in Healthy Weight Men and Women	Postprandial oxidation and inflammation	Tomato extracted lycopene	Not applicable
NCT03617068	The Effectiveness of Coconut Oil Cream as a Prevention Treatment for Occupational Hand Dermatitis Among Batik Workers	Hand dermatoses	Cocos Nucifera Whole	Phase 3
NCT03354299	Effect of Coconut Milk Supplementation to Improve Nutritional Status in Cirrhosis Patient	<ul style="list-style-type: none"> • Malnutrition • Cirrhosis, liver 	Coconut milk	Not applicable
NCT02152111	Hipoenergetic Effect of Diet Associated or Not With the Consumption of Coconut Flour in Women With Overweight	<ul style="list-style-type: none"> • Obesity • Cardiovascular risk factor 	Coconut flour	Not applicable
NCT03931434	Effect of Aged Garlic Extract (AGE) on Improving Coronary Atherosclerosis in People With Type 2 Diabetes Mellitus	<ul style="list-style-type: none"> • Coronary arteriosclerosis • Endothelial dysfunction • Type 2 diabetes mellitus 	Aged garlic extract (AGE)	Not applicable
NCT01534910	Effect of Aged Garlic Extract on Atherosclerosis (Garlic4)	Metabolic syndrome	Aged garlic extract	Phase 4
NCT00200785	Identifying the Anti-Blood-Clotting Compounds in Garlic	<ul style="list-style-type: none"> • Arteriosclerosis • Intracranial arteriosclerosis 	Garlic powder added to ambient water and boiling water	Not applicable
NCT03926806	Yoghurt Consumption, Body Weight Management and Glycemic Control of T2DM Patients	Type 2 diabetes mellitus	Plain yoghurt and vitamin B yoghurt	Not applicable
NCT02629341	Functional Yoghurt Powder Effect on Bone Health Biomarkers (bonefoods)	Osteopenia	Functional yoghurt powder and control yoghurt powder	Phase 3
NCT02494739	Antioxidant and Anti-inflammatory Effects of Yoghurt Enriched With Polyphenols	<ul style="list-style-type: none"> • Oxidative stress • Inflammation 	Yoghurt	Not applicable
NCT03326934	Impact of Dark Chocolate on Visual Performance	Dietary supplementation	Dark chocolate	Not applicable
NCT02130141	The Effects of Dark Chocolate on Blood Pressure in Individuals With Mildly Elevated Blood Pressure (CHOKO)	Blood pressure	Dark chocolate	Not applicable
NCT01431443	Consumption of Chocolate in Pregnant Women. (CHOCENTA)	Preeclampsia	Flavanol-rich chocolate	Phase 2
NCT03680027	Effects Of Walnut-Enriched Diet On Blood Lipids And Glucose Profiles In Hyperlipidemic Subjects	Hyperlipidemias	Walnut-enriched Group	Not applicable
NCT00901043	Effects of Walnut Consumption on Endothelial Function in Type 2 Diabetes (WALNUT)	Diabetes mellitus type 2	Walnut supplementation	Not applicable
NCT02764749	Cranberry (Poly)Phenol Consumption on Vascular Function	Healthy young	Cranberry (poly)phenol containing supplement	Not applicable
NCT03042273	High Strength Cranberry Supplementation for Prevention of Recurrent Urinary Tract Infection	Urinary tract infection	High strength cranberry	Phase 2
NCT02556749	Effects of Cranberry Juice on Cardiovascular Risk Factors	Cardiovascular disease risk factors	Cranberry juice beverage	Not applicable
NCT01531062	Effect of Nigella Sativa on Lipid Profiles in Elderly	Dyslipidemia	<i>Nigella sativa</i>	Phase 2

Table 4 (continued)

Identifier	Title of the study	Condition/disease	Treatment	Status
NCT04347382	Honey & Nigella Sativa Trial Against COVID-19 (HNS-COVID-PK)	Coronavirus infection	<i>Nigella sativa</i> /black cumin and honey	Phase 3
NCT01235832	The Effect of Avocado on Cardiovascular Disease (CVD) Risk Factors	• Cardiovascular disease • Hyperlipidemia	Avocado diet	Not applicable
NCT01929564	Broccoli and Vascular Health Study (BASH)	Cardiovascular diseases	Beneforte broccoli and Parthenon broccoli	Not applicable
NCT00994604	The Effects of Broccoli Sprout Extract on Obstructive Lung Disease	• Asthma • COPD	Broccoli sprout extract	Not applicable
NCT01398176	Immune Benefits From Mushroom Consumption	Healthy humans	Mushrooms	Not applicable
NCT01815437	Evaluating Vitamin D Content in Mushrooms	Vitamin D deficiency	Mushroom vitamin D2	Not applicable
NCT02093130	Study of Pomegranate Juice on Memory in Older Adults	Memory	Pomegranate juice	Phase 2
NCT03902288	Short-term Effect of Pomegranate Juice on Blood Sugar and Its Controlling Hormones in Pre-diabetic and Type II Diabetic Patients.	Patients with type 2 diabetes	Fresh pomegranate juice	Not applicable

Conclusion

As discussed, nutriments are essential diet supplements that can cure the symptoms of specific diseases and are therapeutically active foods. Based on their cost-effectiveness, easy availability and convenient cultivating procedures, specific nutriments were selected for this review. These nutriments are available in almost every region and are consumed by people of all classes daily. They can be added to the daily lifestyle and can lead to a new era in medicine and health. Nutraceuticals cover a wide range of therapeutic areas such as anti-inflammatory, anti-carcinogenic, anti-hypertensive, anti-hyperlipidemic, antioxidants, anti-and hyperglycemic. The antioxidant defence mechanism of the body deprives with the growing age, and nutraceuticals may pave the way for treating disorders occurring due to this oxidative stress. More research work is going on and is at the peak for the rising nutraceutical field. Hence, it can be concluded that nutriments can provide proven health benefits. Their intake can be beneficial in a natural form and maintain overall human health.

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Data availability Not applicable.

Declarations

Ethical approval Not applicable.

Consent to participate Not applicable.

Consent to publish All the authors have approved the manuscript for publication.

Competing interests The authors declare no competing interests.

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