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Nutrient rich foods in human diet as immunity boosters

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Abstract
Adequate nutrients are required for all kinds of cells to develop immune systems in the body. Among edibles, seeds are enriched with proteins, healthy fats, dietary fibres and minerals such as magnesium potassium, calcium, iron and zinc and contain vitamins such as B_1, B_2, B_3 and vitamin E. Nuts have high calorific value, unsaturated fatty acids, dietary fibres, proteins, antioxidants, vitamins E, B_6, folic acid, niacin and minerals such as magnesium, zinc, iron, copper, selenium, phosphorus and potassium and less saturated fats and cholesterols. Among vitamins, A, C, E, D and B_6; minerals including zinc, selenium and amino acids like glutamine play a vital role on developing immune systems in the body. Most of the indigenous fruits of India are underutilized and under-exploited and are rich in vitamins, minerals, nutrients and has medicinal potential. As source of essential vitamins, micronutrients, protein, antioxidants and other phytonutrients, traditional vegetables, underutilized legume crops, spices, edible mushrooms and medicinal plants have the potential to play a major role in developing strategies to attain nutritional security. In the present review, 16 fruit crops, 19 vegetable crops, 19 medicinal plants of Indian origin and 19 popular edible flowers having capacity to develop immunity of individuals is discussed.

Keywords: Immune systems, vitamins, minerals, indigenous, fruits, vegetables, medicinal plants, edible flowers

Introduction
It is well known to everybody that World Health Organization has declared Corona Virus Infectious Disease (COVID-19) as a pandemic and according to their report millions of people from more than 200 countries got infected by COVID 19 which causes huge casualities. This disease develops common symptoms including fever, cough, shortness of breath or difficulty breathing and other associated symptoms like tiredness, arches, chills, sore throat, loss of smell, loss of taste, headache, diarrhea and severe vomiting. In case of older persons, it causes worsened symptoms, such as worsened shortness of breath, multi-organ failure, respiratory failure, heart problems, acute kidney injury and pneumonia [1]. While practicing hygiene are basic necessities it is also important to improve the immune system of an individual to function and fight against virus properly. The most potent anti-viral food items preferably of native origin that must be included in ones diet to boost up the immune system and protect body against infectious diseases.

Immune systems
The immune system should be constantly alert and it must monitor for signs of invasion or danger. Cells of the immune system should be able to differentiate self from non-self and furthermore distinguish between non-self molecules which are harmful as received from pathogens and non-self molecules obtained from foods [2]. Immunity provides protection to life, mediated through cellular response, and humoral immune response. The body usually promotes systematic immune processes by regulating the formation of T lymphocytes, antibodies, and cytokines. Adequate nutrients are needed for all cells to develop immune systems in the body. A single nutrient can exhibit a variety of immunological effects like vitamin E which acts as both antioxidant, inhibitor of protein kinase C activity and interact with enzymes and transport proteins [3]. Besides, minerals such as zinc [4] and selenium [5], aminoacids like glutamine [6] and vitamin D [7] play a vital role on developing immune systems in the body.

Seeds and nuts
Seeds are botanically mature ovules and enriched with proteins, healthy fats, dietary fibres and minerals such as magnesium potassium, calcium, iron and zinc and contain vitamins such as B_1, B_2, B_3 and vitamin *E. oily* seeds are rich in antioxidants which prevent fats from rancidity.

Commonly edible seeds include pumpkin seeds, opium seeds, flax seeds, sesame seeds, sunflower seeds, mustard seeds, amaranth seeds, oat seeds, barley seeds, black rice seeds, brown rice seeds, quinoa seeds, nigella seeds and millet seeds. Seeds can be of good substitute for meat, fish and eggs since they are rich sources of fibre, protein, iron, zinc and vitamins. Seeds should be eaten with the vitamin C rich foods such as tomato, capsicum and citrus juices to boost up iron absorption. Most of edible seeds help to reduce the risk of heart diseases, diabetes and regulate body weight. Seeds like flax seeds which are full of Omega 3 fatty acids and fibres produce energy and boost up immunity. Turmeric containing curcumin increases the immunity boosting proteins in our body. Pumpkin seeds, rich in zinc aid in development and functioning of body's infection fighting white blood cells. Protein rich oilseed meals obtained from soybean, peanut, rapeseed and flaxseed when mixed with other ingredients like cereal grains can provide nutritionally balanced diets [8]. Oilseeds are high in fat, protein, and fibre contents, but low digestible carbohydrates levels, and these characters have been related with decreased levels of glucose and insulin, low glycemic index, and high satiety [9].

Hemp seed oil can provide adequate amount of antioxidants, carotene, phytosterols, phospholipids and minerals including calcium, magnesium, sulfur, potassium, phosphorus, along with modest amounts of iron and zinc. Mustard seeds are good source of many health benefiting minerals. Calcium, manganese, copper, iron, selenium and zinc which help in body metabolism and nervous systems. The Cucurbit seeds and their defatted cakes have large amount of proteins (28 to 40.49% and 61 to 73.59%, respectively). They also contain high lipid levels similar to other oilseeds. These seeds can be considered as sources of proteins and oils [10]. Consumption of edible seeds may be adjuvant for the management of obesity and other inflammatory diseases [11]. Sesame seeds are good sources of dietary fibre, protein, vitamin B, copper, manganese, calcium, and magnesium. They have many health benefits such as preventing diabetes, reducing risk of cancer, protecting DNA from radiation damage, reducing signs of aging, facilitating digestion, boosting oral health, and lowering the risk of cardiovascular diseases.

Amaranthus seeds are the rich sources of protein as well as fibre, vitamin B, folate, manganese, magnesium, phosphorus, and iron. They have several health benefits such as lowering cholesterol, reducing inflammation, aiding in weight loss, maintaining healthy cholesterol levels, improving the immune system, supporting individuals with celiac related diseases, eliminating constipation and bloating, reducing risks of colon cancer and strengthening heart health [12]. Of all the cereal grains, oats are highest in protein and the lowest in carbohydrates. They have capacity to reduce health hazards including lowering cholesterol levels, increasing appetite-control hormones, preventing heart disease, reducing the risk of type 2 diabetes, controlling diabetes, and improving the immune system. Barley seeds are well filled with nutrients, vitamins, and minerals such as dietary fibre, niacin, vitamin B, thiamin, riboflavin, manganese, selenium, phosphorus, and copper. It has several beneficial effects on health like controlling diabetes, protecting skin elasticity, boosting the immune system, maintaining colon health, preventing heart disease and cancer, and lowering the risk of osteoporosis. Black rice grains are full of antioxidants, vitamins, and nutrients that assist to develop a healthy immune system. Brown rice is rich in several minerals such as calcium, iron, magnesium, manganese, phosphorous, potassium, selenium and vitamins such as B, vitamin E, and vitamin K. It is also a great source of essential fatty acids, protein, and fibre. It has a number of health advantages including preventing heart disease, lowering risk of cancer, maintaining weight control, controlling diabetes, and reducing cholesterol levels [13]. Soybeans are enriched with dietary fibre, vitamin K, vitamin B, manganese, iron, phosphorus, and magnesium. It contains the huge amount of protein and ideal foods for vegetarians and vegans. It has several health benefitting effects including preventing osteoporosis, managing weight, preventing heart attack, improving blood circulation, fighting against sleep disorders, reducing cholesterol levels, regulating digestion, and boosting metabolic activity in the body. The rich source of vitamins and minerals of millets perform vital role in our body to boost our immune response towards pathogens.

A nut is a simple dry fruit with one or two edible kernels inside a hard shell. Nuts are rich in high calorific value, unsaturated fatty acids, dietary fibres, proteins, antioxidants, vitamins E, B_6, folic acid, niacin and minerals such as magnesium, zinc, iron, copper, selenium, phosphorus and potassium and low in saturated fats and cholesterols. Popular edible nuts used as foods are almonds, cashewnut, brazil nuts, pistachio nuts, walnuts and pea nuts. Nuts help in weight regulation through fat absorption in the body, promotion of fullness and suppression of hunger and balance of energy expenditure. Frequent nut consumption is associated with lower risk of dying from heart diseases because of rich sources of healthy unsaturated fats, protein, fibre, phytochemicals, vitamins and minerals. Nuts are considered as best sources of healthy fats such as monounsaturated and polyunsaturated fats, and low in unhealthy saturated fats. Both polyunsaturated and monounsaturated fatty acids help to reduce low density lipoprotein (LDL) cholesterol in the body. LDL cholesterol can aid to the build-up of plaque inside the arteries, which causes them to become narrow and subsequently can lead to coronary heart disease. Besides reducing LDL cholesterol, nuts also help to maintain healthy blood vessels and blood pressure through their arginine content, and reduce inflammation in the body through their high antioxidant content. Nut consumption can reduce incidence of gallstones in both genders and diabetes in women. Besides, it has beneficial effects on hypertension, cancer, and inflammation. Interventional studies have indicated that nut intake has a cholesterol-lowering effect, even in the context of healthy diets, and there is prominent benefitting effects on oxidative stress, inflammation, and vascular reactivity. Blood pressure, visceral adiposity and the metabolic syndrome also appear to be positively affected by nut consumption [14].

Nuts are also adequate source of tocopherols, mainly found in almond and hazelnut [15], and high contents of phytosterols and carotenoids as in pistachio nuts [16]. These are rich in vitamin B_6 which is required for a healthy immune system.

Phenolic compounds are the most abundant in nuts especially flavonoids and tannins, largely found in walnut and pecan [17]. Walnuts are an excellent source of several vitamins and minerals, including copper and vitamin B_6. Copper found in fresh walnuts helps to maintain bone, nerve, and immune system. Vitamin B_6 strengthens the immune system and support nerve health. Almonds have capacity to reduce several health hazards like including lowering blood pressure, controlling blood sugar, regulating cholesterol level, alleviating constipation, respiratory disorders, and anemia; improve in hair repair and growth, nail strengthening, and dental strength and care. They have Vitamin E and C which

are great immune boosters. Cashews can provide nearly 100 per cent of recommended daily copper intake. It is an important nutrient for the growth of new blood vessels and for maintaining healthy immune system. Cashews also contain vitamin C and B, which are important building blocks of the body and maintains good health. Zinc obtained from a plant based food like cashews is very beneficial to boost up immune systems in the body. Brazil nuts contain several mineral nutrients including selenium, zinc and iron which are vital for the immune system. Peanuts are rich in protein, monosaturated fats, niacin and manganese. Niacin plays an important role in energy production through the synthesis of food and helps to develop a healthy immune system in the body [18].

Indigenous fruits and vegetables

Most of the indigenous fruits are underutilized and are rich in vitamin, minerals, nutrients and have medicinal potential. Many traditional or under-utilized vegetables are characterized by a high nutritional value compared with global vegetables like tomato and cabbage. As source of essential vitamins, micronutrients, protein, antioxidants and other phytonutrients, traditional vegetables and underutilized legume crops have the potential to play a major role in strategies to attain nutritional security [19].

India is a native of a number of underutilized fruits such as Aonla, Ber, Carambola, Rose apple, Karonda, Mangosteen, Latka, Paniala, Sitaphal, Bread fruit, Mulberry, Ramphal, Phalsa, West Indian Cherry, Hog Plum, Bakul, Pumelo, Wild Mango, Chalta, Durian, Jalpai, Elephant apple, Bael, Jangli Badam, Sweet Tamarind, Mahua, Kendu, Vella, Dampe, Jamun, Wild date, Star Goose Berry, Monkey Jack, Gol pata, Mangrove Apple, Water Chestnut, Chironji, MiricaTenga, Rabab, Kodak, Kolu, Emppe, Tader, Indian Chest Nut, Tayek, etc., rich sources of carbohydrates, protein fat, minerals, vitamins, anthocyanins and organic acids which play a vital role in preventing a number of serious ailments in human body [20, 21]. A number of indigenous fruits having nutritional value and medicinal properties in terms of immunity development against serious ailments are described in Table 1.

Table 1: Indigenous fruits of India for immunity development [22, 23]

Common name	Botanical name	Nutritional value	Medicinal properties
Aonla/Amalaki/Amla/ Indian Goose Berry	*Emblica officinalis*	Vitamin C, proteins and minerals like calcium, hosphorus and iron	As a rejuvenative to promote longevity, enhance digestion, treat constipation, reduce fever, purify the blood, reduce cough, alleviate asthma, strengthen the heart, improve the eyes, stimulate hair growth, enliven the body, and enhance intellect.
Black Mulberry	*Morus nigra*	Sugar (9%), malic acid and citric acid	The fruit is used in the treatment of urinary incontinence, tinnitus, premature greying of the hair and constipation in the elderly. The root bark is antitussive, diuretic, expectorant and hypotensive. It is used internally to treat asthma, coughs, bronchitis, oedema, hypertension and diabetes.
Chironjii or Lanzan	*Buchanania lanzan*	Proteins and vitamins like B_1, B_2, C and niacin	Leaf juice is digestive, expectorant, aphrodisiac, purgative, blood purifier, whereas seeds are used in the preparation of heart and brain tonic, stomachic and febrifuge.
Citron	*Citrus medica*	Iso-limonene, citral, limonene and vitamins like A, C, niacin and thiamin	Ripe fruits are potent anti-scorbutic, stomachic, cardiac tonic, stimulant, sedative, analgesic and used in dyspepsia, bilious vomiting, cold, fever, palpitation, sore throat, cough, asthma, thirst, hiccough and earache. Seeds are anthelmintic, stomachic, sedative, cardiac tonic and useful in palpitation; flowers and buds are astringent and used in blood disorders and peels are anthelmintic.
Indian Almond	*Terminalia catappa*	Proteins, sugars, high calorific value	Leaves are used in the treatment of liver diseases, dysentery and diarrhoea. Leaves have anti-carcinogenic and anti-oxidant properties. Kernels are administered in the treatment of sexual problems.
Jackfruit	*Artocarpus heterophyllus*	Carbohydrate, protein, vitamin A, C, flavonoid pigments and minerals like Fe, P, K and Ca.	The fresh fruit play vital roles in antioxidant, anti-cancer, anti-inflammatory functions in addition to keeping healthy eyesight. It regulates heart rate and blood pressure in the body.
Kokam	*Garcinia indica*	Protein, tannin, pectin, sugars, fat, organic acids like (−)-hydroxycitric acid, hydroxycitric acid lactone and citric acid; the anthocyanins,	Fruits are edible and useful in cooling effect during summer. It reduces indigestion, acidity, flatulence, constipation and diarrhoea. This is an important immunity booster because it is rich in anti-oxidants and it possesses anti-viral, anti-bacterial and anti-helminthic properties.
Phalsa	*Grewia asiatica*	Vitamins A, C and minerals like Fe and P.	Unripe fruits are administered against in respiratory, cardiac, blood disorders and fevers. The bark infusion is used as a demulcent, febrifuge and treatment for diarrhoea.
Pummelo/ Jambura	*Citus grandis*	Vitamin A, B and C.	It is used in folk medicine in many countries as antimicrobial, antioxidant, larvicidal, hepatoprotective, anticancer, antiplatelet, antidiabetic and anti-inflammatory. It can cure fever, gout, arthritis, kidney disorders and ulcers. The fruits pulp and peels are useful as an appetizer, stomach-tonic, inflammation, cardiac stimulant and coughs. The fruit juice is used in stomach tubules. The fruit is nutritive, cardiotonic and refrigerent. The seeds are employed against dyspepsia, coughs and lumbago whereas fruits are used in the treatment of coughs, fevers, cardiotonic, cancer and gastrointestinal disorders.
Soe-phie	*Myrica nagi*	Protein, vitamin C, phosphorus, potassium,	Barks, flowers, fruits and roots are used in Ayurvedic medicines for the treatment of anaemia, asthma, bronchitis, coughs, colds, dysentery, fever,

		calcium	piles, sores, throats problems, ulcers and urinary infections.
Sohiong	*Prunus nepalensis*	Antioxidants, phosphorus, sulphur, iron, copper	Fruits are astringent, antioxidant and anti-hepatotoxic. Leaves are diuretic and used for edema.
Star Goose Berry	*Phyllanthus acidus*	Carbohydrate, protein, lysine, proline, ascorbic acid, niacin, thiamin, sodium potassium and calcium	It used to treat a wide spectrum of diseases such as inflammatory, rheumatism, bronchitis, asthma, respiratory disorder, hepatic diseases and diabetes.
West Indian Cherry	*Malphigia punicifolia*	Vitamin C, A, B, iron, calcium, phosphorus and anthocyanins	It is used for the common colds, diarrhea, liver problems and vitamin C deficiency.
Wild Date Palm	*Phoenix sylvestris*	Carbohydrate, phenol, amino acids, flavonoids, tannins, alkaloids, terpenoids, fibres, vitamins and minerals	It is antipyretic, cardiotonic, laxative, diuretic and antioxidant
Wild Strawberry	*Duchesnea indica*	Vitamins, minerals and dietary fibres	The whole plant is anticoagulant, antiseptic, depurative and febrifuge. Crushed leaves are used as poultice on swellings. An infusion of the flowers is used to activate blood circulation. The fruit is used to treat skin diseases.
Wood Apple/ Kaith	*Feronia limonia*	Carbohydrate, protein, fat, fibre and mineral matter as well as vitamin C, niacin, thiamin, riboflavin etc.	The fruit is used as a liver and cardiac tonic and ripe fruits are used as an astringent to halt diarrhoea and dysentery and as an effective treatment for hiccough, sore throat and diseases of gum. Juice of young leaves is mixed with milk and sugar candy and prescribed as a remedy for biliousness and intestinal troubles of children.

Vegetables are good source of vitamins, minerals, proteins, dietary fibres and other phytochemicals. Vegetables may be of different kinds and they are edible roots, stems, leaves, fruits and seeds [24].

North Western and Eastern Himalayan region is rich in diversity of leek, shallot, other alliums, asparagus, spinach, chenopods, amaranths, chilli, bean, horse radish, colocasia, parsley, chow-chow and *Cyclanthera pedata*. North-Eastern region is blessed with underutilized solanaceous vegetables, leafy vegetables, legume vegetables like winged bean, jack bean, sword bean and cucurbits like chow chow and meetha karela. Gangetic plains harbour minor vegetables like cucurbits and aquatic leafy vegetables. The Indus Plains is enriched with biodiversity in amaranth, *Cucumis*, *Chenopodium*, *Momordica* and *Citullus*. The Central region is rich in minor cucurbits like melon, bitter gourd, pointed gourd and ridge gourd. Underutilized vegetables possess a vast potential to eradicate the curse of malnutrition by providing high calorie value food to the poor (Table 2).

Table 2: Indigenous vegetables of India for immunity development [25]

Common name	Botanical name	Nutritional value	Medicinal properties
Amaranth	*Amaranthus tricolor*	Vitamin A, K, B6, vitamin C, riboflavin, folic acid and minerals like Ca, Fe, Mg, P, K, Zn, Cu, and Mn; protein, lycine	Regular intake reduces hypertension, cardiovascular disease, blood pressure and cholesterol levels.
Bleeding Heart	*Clerodendrum colebrookianum*	Alkaloids, flavonoids, phenols, saponin, glycosides, carbohydrates, proteins and amino acids, fixed oils and fats	A common medical plant used against rheumatic pains by Khasi and Jaintia tribes of Meghalaya. Roots with bark and leaves are effective in coughs, dysentery & asthma. The leaves are vermifuge. Decoction provides relief in high blood pressure.
Brihati	*Solanum indicum*	Dietary fibre, protein, vitamins like thiamin, riboflavin, niacin	Seeds, roots, leaves and berries are used against bronchitis, asthma, cough, dysuria, leucoderma, sexual disorders, insomnia, cardiac weakness and rhinitis.
Chekurmanis / Katuk / Sweet Leaf Bush	*Sauropus androgynus*	Protein, vitamin A, B, C, D, F and K.	Traditionally, leaves are used in the treatment of genitor-urinary diseases, cardio-vascular diseases and other ailments like eye vision and skin problems. Leaves have good antioxidant properties.
Curry leaf	*Murraya koenigii*	Dietary fibre, protein and minerals	The leaves, barks and roots are used as a tonic and a stomachic. The bark and the roots are used as a stimulant. The green leaves are consumed raw for curing dysentery and diarrhoea. The branches are said to strengthen the gum and the teeth.
Drumstick	*Moringa oleifera*	Beta-carotene, vitamin C, protein and iron.	The leaves are reported to have a stabilizing effect on blood pressure and to control glucose levels. They are also used to treat anxiety, diarrhoea and inflammation of the colon, skin infections, scurvy, intestinal parasites and many other ailments.
Indian Pennywort / Thankuni / Gotu Kola	*Centella asiatica*	Vallarine, asiaticoside, sitosterol, tannin and oxy-asiticoside	Gotu Kola is anti-bacterial, anti-viral, anti-inflammatory, anti-ulcerogenic, anxiolytic, a cerebral tonic, a circulatory tonic, a diuretic, nervine and vulnerary. The decoction of juice from leaves is reported to relieve hypertension. The juice is used as a general tonic for good health. It is used to revitalize the brain and nervous system.
Indian Spinach	*Basella alba*	Protein, iron, vitamin A, vitamin C and calcium, vitamins, minerals, aminoacids and soluble fibre	The plants are androgenic, anti-diabetic, anti-inflammatory, anti-microbial, antioxidant, anticancer, antiviral, CNS depressant, hepato-protective and wound healing.

Kachari	*Cucumis callosus*	Vitamin A, C and potassium	The dehydrated kachari is diuretic, gastric stimulant, cooling refrigerant, coughicide and wormicide. It is effective in digestion, facial paralysis, debility, bile, obesity, piles, constipation and cough.
Kantakari	*Solanum xanthocarpum*	Protein, fibre, glucoalkaloid like Solanocarpine	It is useful in the treatment of bronchial asthma, cough, worms etc. The fruits facilitate the seminal ejaculation, alleviate worms, itching, fever and reduce fats.
Latjira/Chirchita	*Achyranthes aspera*	Carbohydrates, vitamins, proteins and achyranthine	It is useful in the treatment of vomiting, bronchitis, heart disease, piles, itching abdominal pains, ascites, dyspepsia, dysentery, blood disease.
Lingura	*Diplazium esculentum*	Antioxidant, vitamin-A, vitamin C, potassium, copper and carotenes	Decoction of the plant is used in coughs and as tonic.
Patharchur	*Coleus aromaticus*	Protein, dietary fibre, essential oils	A decoction of its leaves is administered in cases of chronic cough and asthma. It is considered to be an antispasmodic, stimulant and stomachic and is used for the treatment of headache, fever, epilepsy and dyspepsia. It is used to treat in indigestion, diarrhoea, nervous tension, insect bites, toothache, earache, rheumatism, whooping cough, and bronchitis.
Punarnava / Pigweed / Hogweed	*Boerhaavia diffusa*	Flavanoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins, fat, aminoacids, Punarnavine	Roots are used in the treatment of piles. The root-paste is applied to cure blood dysentery. The decoction of the plant is given in the treatment of nodules in the body. The root juice is used in treating asthma, scanty urine and internal inflammation disorders. The whole plant is useful for curing leucorrhoea, rheumatism, stomachache, high blood pressure and seminal weakness. The punarnava possesses punarnavoside which are diuretic, anti-inflammatory, anti-fibrinolytic, anti-bacterial, anthelmintic, anti-nematodal and anti-viral.
Snake gourd	*Trichosanthes anguina*	Carbohydrates, proteins, minerals and vitamin A, B and C.	It increases appetite acts as a tonic, stomachic and cures biliousness. The roots and seeds are anthelmintic and used in the treatment of diarrhoea, bronchitis and fever.
Sweet Gourd/ Spiny Bitter Gourd	*Momordica cochinchinensis*	Lycopene, beta-carotene, fatty acids and proteins.	It is a good source of antioxidant due to the presence of carotenoid compounds and has anti-carcinogenic affects. Besides, it lowers the risk of strokes and heart diseases.
Vegetable banana	*Musa paradisiaca*	Energy, carbohydrate, fat, protein, Vitamin A, Vitamin B, Vitamin C, K, P, Ca and Fe	Banana flower is a good anti-oxidant and cooked in soups and curries. Besides, flower cures infection, slows the aging process, promotes heart health, improves digestion, promotes mental relaxation, supports menstrual health, regulates blood sugar and cures anaemia. The tender core of pseudostem is used as vegetables. The juice extract from tender core is used to remove stones from kidney, gall bladder and prostrate. Pseudostem juice is a well-known remedy for urinary disorders, diarrhoea, dysentery and flatulence.
Water spinach	*Ipomoea aquatica*	Protein, carbohydrates and vitamin C	In Ayurvedic medicine, it is used to treat jaundice and liver problems. Leaves are used to treat diabetes. It is used to cure fever, jaundice, bronchitis and general debility of women.
Wild coriander	*Eryngium foetidum*	Vitamin A, B, C, Fe, carotene, calcium and aliphatic aldehydes	A decoction of leaves has an anti-inflammatory effect and used against diarrhoea, flu, fevers, vomiting, diabetes and constipation.

Indigenous medicinal plants

India is enriched with 8000 species of medicinal plants of which the *Ayurveda* system of medicine uses about 700 species, *Unani* 700, *Siddha* 600, Amchi 600 and modern medicine around 30 species which are rich in alkaloids, glycosides, flavonoids, sugars, pigments, alcohols and pigments with immunomodulatory actions (Table 3).

Table 3: Indigenous medicinal plants of India for immunity development [26]

Common name	Botanical name	Chemical ingredients	Medicinal properties
Acid lime	*Citrus aurantifolia*	Vitamin C, citric acid, sugar, certain minerals like calcium and phosphorus and essential oils	It develops the resistance of individuals to several diseases, cures wound healing and increases the health of eyes. It improves the maintenance of good dentition and keeps away toothache, dental caries, swollen gums, fragility of bones and bleeding of the gums. Lime is vital in the treatment of gastric disorders like indigestion, constipation and peptic ulcer.
Anantmool	*Hemidesmus indicus*	Coumarin and two sterols –hemidosterol and hemidesmol, resins and tannins, carotenoid, provitamin A, vitamin C, tannins phenolics, anthocyanins, reducing and non-reducing sugars and anti-nutritional factors.	The roots are useful in vitiated conditions of *pitta*, burning sensation, leucoderma, leprosy, skin diseases, pruritus, asthma, bronchitis, hyperdipsia, opthalmopathy, hemicrania, epileptic fits, dyspepsia, helminthiasis, diarrhoea, dysentery, haemorrhoids, strangury, leucorrhoea, syphilis, abscess, arthralgia, fever and general debility. The leaves are useful in vomiting, wounds and leucoderma. The stems are bitter, diaphoretic and laxative and are useful in inflammations, cerebropathy, hepatopathy, nephropathy, syphilis, metropathy, leucoderma, odontalgia, cough and asthma.
Aswagandha	*Withania somnifera*	Alkaloids, starch, reducing sugar, hentriacontane, glycosides, dulcital,	Roots, leaves and seeds are used in Ayurvedic and Unani medicines, to combat diseases ranging from tuberculosis to arthritis. Roots are

		withaniol acid	used in medicines for hiccup, several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammations and skin diseases. Roots and paste of green leaves are used to relieve joint pains and inflammation. It is also an ingredient of medicaments prescribed for curing disability and sexual weakness in male. Leaves are used in eye diseases. Seeds are diuretic. It is a well known rejuvenating agent capable of imparting long life, youthful vigour and intellectual power. It improves physical strength andis prescribed in all cases of general debility.
Bael/Golden apple	*Aegle marmelos*	Protein, mineral like P, K, Ca, Mg and Fe, furocoumarin and marmalosin	Leaves are made into a poultice and used in the treatments of opthalmia. The roots are sweet, used in fevers, abdominal pain, palpitation of the heart and urinary troubles. They are useful in disorders like pitta and kapha.
Black turmeric	*Curcuma caesia*	Camphor, curcumin, turmerone, cineole	It is useful in the treatment of piles, leprosy, bronchitis, asthma, cancer, epilepsy, fever, wounds, fertility, menstrual disorders, toothache, vomiting.
Brahmi	*Bacopa monnieri*	Brahmine, hespestine, saponins	This is an important drug in Ayurveda for the improvement of intelligence and memory and revitalisation of sense organs. It clears voice and improves digestion. It is recommended against dermatosis, anaemia, diabetes, cough, dropsy, fever, arthritis, anorexia, dyspepsia, emaciation, and insanity. It dispels poisonous affections, splenic disorders and impurity of blood. It is useful in vitiated conditions of *kapha* and *vata*, biliousness, neuralgia, ascites, flatulence, leprosy, leucoderma, syphilis, sterility and general debility. The plant is anti-cancerous and improves learning ability.
Chingari	*Clerodendrum indicum*	Sapogenins, saponins, triterpenes, and D-mannitol.	The root of chingari is stomachic, expectorant, anti-inflammatory, anti-bronchitis, febrifuge, hence useful for asthma, cough, and scrofulous affections. In Unani medicine, the root increases appetite and lowers fever. The leaves and roots are used externally to treat tumours and certain skin diseases.
Gandhli / Prasdrani/ Skunk vine	*Paederia foetida*	Iridoid glycosides, sitosterol, stigmasterol, alkaloids, carbohydrates, protein, amino acid, dimethyl disulphide, and volatile oil	It is considered as alterative, anti-arthritic, anti-spasmodic, diaphoretic, hepato-protective, anti- ulcerous, vermifuge, anti-tumorous, expectorant and stomachic. The entire plant including stem, leaves and root are useful against asthma, rheumatism, paralysis, gout, toothache, piles and inflammation of liver and abscesses. A soup made from leaf is good for sick and convalescent. Leaves are used as a remedy for diarrhoea and dysentery.
Giloe	*Tinospora cordifolia*	Bitter substances, tinosporine, gilonin, gilosterol, gilenin, and furanoditerpenes.	It is a febrifuge useful in malarial and chronic fever. It is also used a liver tonic. The plant is used in general debility, loss of appetite, fevers, urinary disorders, diabetes, rheumatism, and dyspepsia.
Haritaki	*Terminalia chebula*	Fatty acids *viz*. palmitic, stearic, oleic,linoleic, arachidic and behenic acid; chebulinic acid, tannic acid, gallicacid, chebulin and tannin.	The fruit is a common constituent of "*Triphala*" capable of imparting youthful vitality and receptivity of mind and sense. It is a major constituent in the ayurvedic preparations like *Abhayarishta, Abhayamodak, Haritakikhand, Triphaladi churnam* and *Agastya rasayanam*. In allopathy, it is usedin astringent ointments. In unani system, it is used as a blood purifier. The pulp of the fruit is used in piles, chronic diarrhoea, dysentery, costiveness, flatulence, asthma, urinary disorders, vomiting, hiccup, intestinal worms, ascites and enlarged spleen and liver. Powder of the fruit is useful in chronic ulcers and wounds, carious teeth and bleeding ulceration of the gums.
Heart Leaf/ Rainbow plant	*Houttuynia cordata*	Alkaloids, phenolic acid, chlorogenic acid derivatives, phenolic glycosides, phenylpropanoids derivatives and flavonoids	Whole plant is eaten raw as a medicinal salad for lowering the blood sager level. Leaf juice is consumed for the treatment of cholera, dysentery, curing of blood deficiency and purification of blood. Young shoots and leaves are eaten raw or cooked as a pot-herb. A decoction of this plant is used internally for the treatment of many diseases including cancer, coughs, dysentery, enteritis and fever. Externally, it is used for the treatment of snake bites and skin disorders.
Indian Gentian	*Gentiana kurroo*	Gentiopicrin, gentianin and gentiomarin	The rootstocks are used as bitter tonic, antiperiodic, expectorant, antibilious, astringent, stomachic, anthelmintic, blood purifier and carminative. It is used for curing skin diseases, bronchial asthma and urinary infections. It is also used for improving appetite, stimulating gastric secretion and in the treatment of digestive disorders.
Kalmegh	*Andrographis paniculata*	Andrographolid and kalmeghin	It is useful in hyperdipsia, burning sensation, wounds, ulcers, chronic fever, malarial and intermittent fevers, inflammations, cough, bronchitis, skin diseases, leprosy, pruritis, intestinal worms, dyspepsia, flatulence, colic, diarrhoea, dysentery, haemorrhoids and vitiated conditions of *pitta*. It is used to overcome *sannipata* type of fever, difficulty in breathing, hemopathy due to the morbidity of *kapha* and *pitta*, burning sensation, cough, oedema, thirst, skin diseases, fever, ulcer and worms. It is also useful in acidity and liver complaints.
Kuchla	*Strychnos nux*	Strychnine and brucine vomicine, alpha-	The seeds are used as a remedy in intermittent fever, dyspepsia,

	vomica	colubrine, beta-colubrine, pseudostrychnine and N-methyl-sec-pseudobrucine (novacine)	chronic dysentery, paralytic and neuralgic affections, worms, epilepsy, chronic rheumatism, insomnia and colic. It is also useful in impotence, neuralgia of face, heart disease, spermatorrhoea, skin diseases, toxins, wounds, emaciation, cough and cholera. Leaves are applied as poultice in the treatment of chronic wounds and ulcers and the leaf decoction is useful in paralytic complaints. Root and root bark useful in fever and dysentery.
Mishmi teeta	*Coptis teeta*	Berberine	It is tonic and stomachic. The rhizome is administered in intermittent fever and debility.
Neem	*Azadirachta indica*	Kaempferol, myricetin, desacetylnimbin, azadirachtin, nimbidol, meliantriol, tannic acid, nimbin, nimbinin, nimbidin, nimbosterol, essential oil, tannins, margosine and desacetylnimbin.	It is valuable as an antiseptic, used in the treatment of small pox. Small twigs are used as tooth brushes and as aprophylactic for mouth and teeth complaints. Extract from the leaves are useful for sores, eczema and skin diseases. Boiled and smashed leaves serve as excellent antiseptic. Decoction of leaves is used for purifying blood.
Tulsi	*Ocimum sanctum*	Eugenol	It is recommended for the treatment of bronchitis, malaria, diarrhea, dysentery, skin disease, arthritis, eye diseases, insect bites and so on. It is suggested to possess anti-fertility, anticancer, antidiabetic, antifungal, antimicrobial, cardioprotective, analgesic, antispasmodic and adaptogenic actions.
Turmeric	*Curcuma longa*	Essential oils, curcumin	Traditionally, it is used as a medical herb due to its antioxidant, anti-inflammatory, antimutagenic, antimicrobial and anticancer properties. It is used in the treatment of stomachache, skin problems and arthritis. It has been used as clothing dye and as a cosmetic. In China, it is used as analgesic and for colic, hepatitis, ringworms and chest pain.
Vasak	*Adhatoda vasica*	Vasicine, vasicinone, deoxyvasicine, maiontone, vasicinolone and vasicinol.	The leaves, flowers, fruit and roots are extensively used for treating cold cough, whooping cough, chronic bronchitis and asthma, as sedative, expectorant and antispasmodic.

Edible flowers

Edible flowers are flowers that are eaten. In most of the cases, stems, sepals, petals and stamens are removed before use. They are preserved for future use by using techniques like drying, freezing or steeping in oil. They can be used as a component in drinks, jellies, salads, soups and many several main dishes. Flower-flavoured oils and vinegars are made by steeping edible petals in these liquids. Sometimes candied flowers are crystallized using egg white and sugar. Edible flowers are rich in vitamins, minerals and micronutrients. Oils from flowers are used in aromatherapy, and certain flowers are even used as a dietary therapy due their medicinal value [27]. A number of popular edible flowers having immunity development ability is discussed below.

Agathi *(Sesbania grandiflora)*: A fast growing small tree, 3-5 m tall with regular and rounded leaves. The flowers are white and large. The fruits look like flat, long and thin green beans. A tree yields 4.5-9.0 kg of leaves and 4-6 kg of flowers/year. Leaves are rich in vitamin A, vitamin C, Ca, thiamine, nicotinic acid, riboflavin, protein, fat and iodine. The young pods and leaves are eaten. The flowers are used as vegetables. The juice of leaves and flowers is used in nasal catarrh and headache. Leaf juice is applied to bruises and useful to cure sore mouth. Juice of flowers is applied to the eyes to cure dimness in vision. Agathi is a folk remedy for bruises, catarrh, dysentery, eyes, fevers, headaches, smallpox, sores, sore throat, bronchitis and stomatitis [28].

Basil (*Ocimum basilicum):* It is an erect, almost glabrous herb, 30 to 90 cm tall. The leaves are ovate, lanceolate, cucuminate, toothed or entire, glabrous on both surfaces and glandular. The flowers are white or pale purple and are borne in long terminal racemose inflorescences, in simple or many branched racemes. Ocimum species with oil rich in camphor, citral, geraniol, linalool, linalyl acetatemethyl chavicol, eugenol and thymol are important and can be harnessed for successful utilization by the industry. The whole flower is edible. Flowers are sprinkled over salad or pasta for a concentrated flavor and a spark of color that gives any dish a fresh, festive look. The flowering tops are carminative, antispasmodic, aromatic, digestive, stomachic and tonic [29].

Bee Balm/ Bergamot (*Monarda didyma*): Flowers are minty flavoured. The leaves and flower petals are used in both fruit and regular salads. Monarda flowers are formed by large clusters of edible tubular petals that can be separated before adding to cakes, fancy drinks, or salads. Flowering stems are anthelmintic, carminative, diuretic, expectorant, febrifuge and stimulant.

Broccoli (*Brassica oleracea italica):* A native to Europe. A biennial cruciferous vegetable crop with compact growth habit, 45cm tall bearing stalks and flower buds. The mass of flower heads is usually surrounded by lavish leaves. There are two types of broccoli, heading broccoli forms curd like cauliflower whereas sprouting broccoli contains a group of green immature buds and thick fleshy flower stalk forming a head. It is a cool season crop and a temperature of 15-20ºC is ideal for head formation. Broccoli is rich in vitamins C, K and A as well as dietary fibre. It is high with potent anti-cancer properties such as diindolyl methane and small amounts of selenium. The 3, 3'-Diindolylmethane is a potent modulator of the innate immune system with anti-viral, anti-bacterial and anti-cancer activity. Broccoli is used for cooked, soups and salad purposes. It aids in protection of aggressive prostate cancer and heart diseases.

Cosmos (*Cosmos sulphureus*): This is an annual species of Mexico origin. Plants are 90-120cm tall and produce pale yellow flowers. Different cultivars with orange red, double and early flowering types are available under this species. Flower heads are good yellow colorants. Flowers are edible and used in salads in Thailand. Flowers have antioxidant and anti-inflammatory activities.

Dandelion (*Taraxacum officinale*): It is a hardy perennial having rosette base bearing several flowering stems and

multiple leaves. The common dandelion flower head is arranged with about 150 to 200 yellow ray florets and no disk florets. Leaves, root, and flower are edible. Dandelion leaves are added to a salad or cooked. They can also be dried and stored for the winter or blanched and frozen. Flowers can be made into juice, or added into many recipes. Dandelion buds are tastier than the flowers. They are eaten raw or steamed and can be made into wine. The common yellow dandelion has a long list of powerful healing abilities as well as other health benefits. The flowers have antioxidant activities.

English Daisy (*Bellis perennis*): It is a perennial herbaceous plant with creeping rhizomes and rosettes of small rounded or spoon-shaped leaves. The flower heads are composite, in the form of a pseudanthium, consisting of many sessile flowers with white ray florets and yellow disc floret. The flowers have a bitter flavour, but are entirely edible. They are small enough to use simply by sprinkling the petals onto salads or other meals. Fresh or dry flowers are rich in flavonoids, essential oils, tannins, organic acids, inulin and resins etc. and are used in the treatment of cold, bronchitis and respiratory problems.

Japanese honeysuckle (*Lonicera japonica*): A native to Eastern Asia. It is twining vine, 10m long with simple oval leaves and double tongued white to pale yellow in colour. The long flower tubes of various honeysuckle species are edible, with its distinctly honey-like flavour. The dried leaves and flowers are employed in traditional Chinese medicine and being used to treat fever, cold-related headache, cough, thirst, certain inflammation including sore throat, skin infection, and tumor necrosis.

Impatiens (*Impatiens walleriana*): It is a flowering herbaceous perennial plant, 15–60 cm tall, with broad lanceolate leaves The flowers are hermaphroditic and the flowers may be bright white or shocking red, but the petals are edible and have a surprisingly sweet taste. They can be added into salad or mixed into fancy drinks. The flowers have antioxidant properties.

Lavender (*Lavandula angustifolia*): An annual or short lived perennial with simple or pinnately compound leaves. Flowers are borne in whorls borne in spike rising above the foliages. The flowers are blue, violet or lilac in colour. Flowers have sweet, floral flavor, with lemon and citrus notes. Flowers taste good in a glass of champagne, with chocolate cake, or as a garnish for sorbets or ice creams. Diminutive blooms add a mysterious scent to custards, flans or sharbets. An essential oil from flower is antiseptic, antispasmodic, aromatic, carminative, diuretic, sedative, stimulant, stomachic and tonic.

Lilac (*Syringa vulgaris*): A large deciduous shrub or multi-stemmed tree, 6-7 m tall which produces suckers from the base or roots and ovate to cordate pinnate leaves. Flowers are tubular at base and mauve or lilac in colour. The flowers of lilac have an intensely floral, almost perfumery flavour with lemon undertones. One or two individual flowers added to a summer punch looks wonderful and tastes very refreshing. Flowers are great in salads and crystallized with egg whites and sugar. Flowers are used in the treatment of headache, cough, cold, skin diseases, heart problems and hypertension.

Marigold: Both French marigolds (*Tagetes spatula*) and African marigolds (*T. erecta*) produce flowers that are technically edible. Flowers of French marigold are yellow, orange and unique bronze in colour. In African marigold, flowers are yellow or orange in colour. In *T. tenuifolia*, flowers are yellow, orange, golden or bicoloured borne above the fine textured dark green foliage or tucked in with the foliage depending upon the cultivar. African marigold flowers are used as a food colourant in Europe, but have only been recommended for use as a poultry feed additives. However, *T. tenuifolia* has a refreshing citrus, lemony flavour, and its petals are used in salads or smart drinks. The flowers of *Tagetes erecta* is carminative, diuretic and vermifuge. Flowers are used in the treatment of fever, flu, sore throat, heart attack and arthritis.

Pot Marigold (*Calendula officinalis*): This species is native to South Europe, attains a height of 30-60cm and the flowers are generally orange –yellow. These are hardy herbs. Leaves are large, simple and alternate. These free flowering plants bear double or semi-double flowers of brilliant colour, mostly orange, yellow or lemon. Calendula is ideal for sunny or shady beds or borders and also as cut flowers. It is also useful as a pot plant. Flower petals are edible. They have nice flavour, bitter to peppery in taste and are sprinkled on soups, pasta or rice dishes, herb butters, and salads. Petals add a yellow tint to soups, spreads, and scrambled eggs. The dried flower heads have antipyretic, anti-tumor and cicatrizing effects. Topical application of infusion of flowers is used as antiviral in HIV [30], antifungal, and antiseptic in wounds, marks, freckles, sprain and conjunctivitis and improves immune systems.

Rose (*Rosa gallica*): It is a deciduous shrub having slender and straight prickles of various sizes. The leaves are pinnately-compound, with three to seven bluish-green leaflets. The flowers are clustered one to four together, on glandular pedicels. Flowers have flavor of reminiscent of strawberries and green apples. In miniature varieties, garnish ice cream and desserts, or larger petals can be sprinkled on desserts or salads. They can freezed in ice cubes and floated in punches also. Petals used in syrups, jellies, perfumed butters and sweet spreads. Other valuable products are rose petal jam, rose petal tea etc. The petals have antibacterial, astringent and tonic properties and they are taken to treat cold, bronchitis, gastritis, diarrhea, depression and lethargy [31].

Rosemary (*Rosmarinus officinalis*): It is an evergreen dense highly branched herb or under-shrub grows to a height of 1 m. The long slender branches are arranged with many sessile opposite leaves, smooth and green, woolly whitish and glandular beneath, 2-4 cm long, almost cylindrical and folded inwards; flowers are situated in small clusters towards the ends of the branches. It is used in formulations of compounded oils for flavouring meat, sauces, condiment and other food products. It is used as a culinary herb. A distilled water is obtained from flowers which is used as an eyewash. Rosemary blossoms are used as an alternative to the herb's leaves for a milder flavor and more delicate texture. Rosemary blossoms should be used as a finishing herb in either sweet or savory dishes. The flowering tops and twigs yield essential oils and olerosin, produce functional foods with good antioxidant properties and are used in traditional, modern medicine and aroma therapy.

Sage (*Salvia officinalis*): This species is native to Mexico. The plants are 60-90 cm tall with bright dark green leaves and attractive long terminal spikes of light or deep blue flowers**.**

The deep blue flowers add an interesting mild-sage flavour to salads or savory dishes. Individual flower tubes are pulled from the stems and used with discretion, as the taste is strong. It has anticancer, anti-inflammatory, antioxidant, antimicrobial, hypoglycemic, hypolipidemic, and memory-enhancing effects.

Squash (*Cucurbita pepo*): A creeping annual, velvet hairy plant with ovate heart shaped or triangular heart shaped lobed leaves having serrated margins. Flowers are solitary and borne in leaf axils. The male flowers are stalked, 7-20cm long, bell shaped. The female flowers have sturdy stalks, 2.5 cm long. Fruit varies in shape and sizes and smooth to heavily ribbed, with light to dark green skin colour. The flesh is cream to yellow or pale orange and soft. Both male and female flowers are edible. They can be added to salads or stuffed with savory items like herbs and goat cheese. Mature fruits could be of 3 ft long and cooked as vegetables. It can be eaten raw, sliced or shredded in a cold salad, baked into bread as well as hot and sometimes cooked in hot salads. It has antioxidant, antiviral, antidiabetic and anti-inflammatory activities [32].

Sweet violet (*Viola odorata*): A hardy herbaceous flowering plant, 10-15cm long. The flowers are normally either dark violet or white in colour. The leaves and flowers are all in a basal rosette. The leaf-stalks have hairs which point downwards and the plant spreads with stolons. Young flower buds are eaten raw or cooked. The flowers are anodyne, expectorant, demulcent, diuretic, purgative and emollient and used in the treatment of respiratory ailments. Syrup of the flowers is used for cough and hoarseness.

Yucca: It is a genus of perennial shrubs and trees and characterized by their rosettes of evergreen, tough, sword-shaped leaves and large terminal panicles of white or whitish flowers. Flowers and flower stalks are boiled and roasted and eaten. The high amount of vitamin C and antioxidants in the plant boosts the immune system and overall health.

Edible mushrooms

Mushrooms are popular foods because they have low calorific value, cholesterol free and are rich in selenium, potassium, riboflavin, niacin, vitamin D, protein and fibres. Besides, they are full of secondary metabolites such as terpenes, steroids, anthraquinones, benzoic acid derivatives and quinolones. Mushrooms serve as antibacterial, immunity system enhancer and anti-tumoral. Major cultivated edible mushrooms include *Agaricus bisporus*, *Lentinus edodes*, *Pleurotus* spp, and *Flammulina velutipes* [33].

Conclusion

Our immune systems used to play a tremendous jobs at fighting off foreign cell to protect us against illness. Our bodies develop proteins called antibodies that eliminate abnormal cells. There are certain foods available to be included in our diet which are vital for normal function of our immune systems. Vitamins A, D, E, C, B_6 and minerals like zinc, selenium are the nutrient profiles which are necessary for developing immunity in human body and thereby edible seeds, nuts, nutrient encapsulated indigenous fruits, vegetables, medicinal plants, edible flowers and mushrooms can be included in human diet. In addition, these are the innovative ingredients of future foods for diversification.

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