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Underutilized leafy vegetables of India and their pharmaceutical value to provoke human immune system

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Abstract

The greens otherwise called as leafy vegetables are rapidly growing vegetables and are ready for market in a short period of time. Traditional underutilized leafy vegetable crops are inexpensive, easy to cook, and packed in phytonutrients including minerals which are essential for the metabolic processes and protection of our body as well. A large number of leaves from perennial trees, aquatic plants and terrestrial annuals are consumed especially in rural areas. Leafy vegetables play significant role in alleviating micronutrient deficiency. In India, a good number of such underutilized leafy vegetables which are indigenous to India or being cultivated for a long time have proteins, vitamins, dietary fibres, minerals and phytonutrients needed for human beings. These are embedded with nutraceutical as well as pharmaceutical components which are essential for human wellbeing. Some of the leafy vegetables are also recognized for their medicinal value too. This review deals with the underutilized leafy vegetables consumed locally in Indian villages; their nutrition and medicinal values.

Keywords: Leafy vegetables, nutraceuticals, pharmaceuticals, Underutilized greens, phytonutrients, anti-microbial components

Introduction

Today scenario shows that more than 102 crore people (15% of the world population) are undernourished and hungry (Bal., 2003) [6]. About 92.5 crore people do not have enough food to eat. About 70% of the world's (146 million) underweight children under age five years live just 10 countries; with more than 50% in South Asia. Under nutrition contributes to 53% of the 97 lakh deaths of children under five each year in developing countries. Vitamin and micronutrient deficiencies in human diet are becoming severe diseases especially in young, pregnant women, and children. Vitamin A deficiency affects 25% of the developing world's pre-schoolers and leads to the death of 1-3 million children each year. Approximately 3 million deaths occur in a year from non-communicable diseases due to inadequate fruit & vegetable intake. The most popular approach in addressing these problem in supplementation and the so called "food based strategies", which include nutrition, education and food fortification (Binita, *et al.*, 1997) [11].

All the above data are a proof of insufficient, nutritious food even in today's hi-tech world food production to meet malnutrition and hunger of underdeveloped countries. That's why, agriculture and food sectors are manipulating a new idea to meet food and nutritional demand of a country that of utilizing local underutilized plant species of that region. The underutilized plant species represent enormous untapped commodity resources which can help address the increasing demand for food, nutrition, economic and medicinal needs (Abara, 2008) [1].

Underutilized vegetables

Traditionally, underutilized crops of respective endemic region of a country are known to make a significant contribution to the diet of rural households, particularly during drought, famine and dry season (Agbaire, 2011) [2]. These species include plants that provide edible fruits, grains, leaves, nuts, oils, roots and tubers, fibres, medicines, spices, stimulants and other products. Underutilized species hold great genetic diversity, and vast heritage indigenous knowledge is linked to these species. Indigenous/underutilized vegetables are in danger of being replaced by a few cultivated species (Awasthi, 1984) [5]. Some of these species are highly commercialized, like pumpkin, ashgourd, chow-chow, curry leaf, brinjal, moringa pod etc., while others are semi-cultivated in minor area for local markets. The development of modern agriculture practice has further neglected the potential of many of these hidden resources.

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Underutilized leafy vegetables

The vegetable greens are rapidly growing plants and are ready for market in a short period of time. Traditional underutilized crops are inexpensive, easy to cook, and packed in phytonutrients including minerals which are essential for the metabolic processes and protection of our body as well. The outer leaves are harvested over an extended period, without any adverse effects to the plant. These leaves are usually used in salads in various combinations, making an attractive display of colour and texture. A large number of leaves from different sources such as perennial trees, aquatic plants and terrestrial annuals are consumed especially in rural areas. These vegetables are an economic source to ensure the micronutrient intake (Bhavithra *et al.*, 2019) ^[9]. Leafy vegetables play significant role in alleviating micronutrient deficiency. In India, a good number of such underutilized leafy vegetables are indigenous to Eastern India and these are hidden sources of proteins, vitamins, dietary fibres, minerals and phytonutrients. These are embedded with nutraceutical as well as pharmaceutical components which are essential for human wellbeing and mostly used based on the traditional knowledge, social rituals and as folklores. (Deb *et al.*, 2018) ^[17]. Some of the leafy vegetables are also recognized for their medicinal value too. In general, edible green leafy vegetables appear to be under-utilized or utilized by regional specific peoples/tribes throughout the world and may in some areas even be diminished in use (Bhavithra *et al.*, 2019) ^[9].

Nutritional, Medicinal and Socioeconomic Importance of Underutilized Leafy Vegetables

Underutilized leafy vegetables are good sources of proteins, vitamins, minerals including micronutrients (Patton and Ushadevi, 2014; Pandey *et al.*, 2014) ^[45]. The nutritional value of these wild vegetables is high in comparison to common cultivated vegetables (Nordeid *et al.*, 1996). ^[42] Moreover such vegetables are rich sources of phytonutrients (Mathur *et al.*, 2010; Bandyopadhyay and Mukherjee, 2006; Upadhyay and Saikia, 2012; Sarma *et al.*, 2014, Swapna *et al.*, 2011) ^[39, 7, 72, 58, 67] especially antioxidants in different forms (Mathur *et al.*, 2010; Ho *et al.*, 2012; Mishra *et al.*, 2008; Ujowundu *et al.*, 2008; Joshi *et al.*, 2007) ^[39, 71, 31], different bioflavonoids (Srinivasa *et al.*, 2008; Kavitha *et al.*, 2014) ^[65, 34] etc. Moreover some of the plants are reported as highly anticancerous (Rajasekaran *et al.*, 2014; Choudhury, 2012) ^[54, 14], antimicrobial (Roy *et al.*, 2013; Vijayasanthi and Doss, 2015; Srinivasan *et al.*, 2011) ^[66, 73], hepatoprotective (Sharmila Banu *et al.*, 2009) ^[63], anti-inflammatory (Kaushik *et al.*, 2011) ^[33] and more.

By tradition they are used as natural healers in the tribes and nomadic peoples (Senthilkumar *et al.*, 2014; Shanmugam *et al.*, 2012; Dangol *et al.*, 2008) ^[59, 61, 15]. These underutilized leafy vegetables are naturally growing plants and thus very little attention is required to grow them. In most cases sowing seeds or planting once provides repeated harvest for long duration. Somewhere just maintenance in its natural habitat is also sufficient for collection in a huge amount. Thus cultivation of these plants is helpful for small and marginal farmers to gain good economic returns to the Eastern India region particularly. Apart from food, these underutilized vegetables can be used as potential sources of medicines. The high nutritional qualities indicate that the cultivation and consumption of these crops may be helpful in overcoming the nutritional deficiencies predominant in many rural areas of the country and helpful to boost the socio-economic condition of the society as well.

Reasons for Underutilization

Many of these leafy vegetables are found resilient, adaptive and tolerant to adverse climatic conditions, although they can be raised at lower management costs even on poor marginal lands. Underutilization of these leafy vegetables particularly in the context to Eastern India is due to complex reasons like geographical, social and economic concerns etc. The un-assessable area, geographical isolation, complete unexplored status of agronomic practices of production and ultimate too little institutional interest for these plants are different issues for low production standards of these vegetables (Sing and Munda, 2008). Though existence of diversity in plant types, morphological and physiological variations, adaptations, reactions to diseases and pests, but they have remained underutilized due to lack of awareness and advertisement for utilization. Absence of popularization programme, mobilization of farmers and consumers of all classes towards better utilization of these underutilized leafy vegetables, inadequate facilities towards processing and value addition, bottlenecks in research, weak policy support from different organizations, inadequate marketing facility(ies) and supply chain are the main reasons due to which these crops still remained underutilized. Though, domestication and cultivation of these species very less but recent awareness about the immense nutritional cum medicinal benefit of these underutilized leafy vegetables among the conscious people are projecting the farmers to cultivate the same but the extent of this cultivation is still in question mark.

Leafy vegetables utilized in India and its pharmaceutical values

Acmella oleracea (CN: Toothache plant, Tam: Vanamukali). Family: Asteraceae. Leaves of paracress are boiled or used fresh as a vegetable as an additional source of vitamins (and flavour). The leaves and flowers decoction or infusion is used for curing stammering, toothache, stomatitis and throat complaints. (Deb *et al.*, 2018) ^[17].

Adansonia digitata (CN: Baobab, Tam: Papparappuli). Family: Bombacaceae. Young leave, tender shoots, flowers, fruits, and seeds of baobab/monkey bread tree are consumed. Leaves are rich in vitamin A & C, sugars, potassium tartrate, and calcium. In the folk medicine, pulp used in the treatment of fevers and dysentery, extract applied as eye-drops in case of measles, leaves from a component of many herbal remedies and a mash prepared from the dried powdered roots given to malarial patients as a tonic, a semi-fluid gum, obtained from the bark, is used to treat sores. (Rohini *et al.*, 2017) ^[59].

Alternanthera sessilis (CN: Sessile Joyweed, Tam: Ponnanganni). Family: Amaranthaceae. It is a perennial herb, often found near ponds and water bodies prefer periodically high humidity. Use of the plant as cooked leafy vegetable in India and salad in Sri Lanka is common. It is rich source of proteins and dietary fibre. Besides it is also rich in alpha spinasterol, beta sitosterol, beta sitosterolglucoside, campesterol, oleanolic acid, saponinsstigmasterol etc. It is most effective in skin diseases and effective in acne, asthma, debility, diarrhoea, dizziness, digestive disorder. It is abortifacient, antiulcer, cholegogue, diuretic, febrifuge, galactagogue, memory enhancer, antihyperglycemic (Hossain *et al.*, 2014 and Walter *et al.*, 2014) ^[25, 74]. Stems and leaves useful in eye trouble. Decoction is taken with little salt drunk to check vomiting of blood. Shoot with other ingredients used to restore virility (Gupta *et al.*, 2012) ^[20]. Poulitice used for boils.

Alternanthera philoxeroides (CN: Alligator weed). Family: Amaranthaceae. It is an immersed aquatic plant, originated in South America, a sprawling herb, stems are pinkish, can become hollow when larger. The plant is a good source of like calcium, Iron, potassium, dietary fibre, different sterol compounds etc. Whole plant contains 7 α -L-rhamnosyl-6-methoxy-luteolin, oleanolic acid, Coupling glucose, ribose and saponin components of rhamnose. Stem leaves contain alternanthin, β -sitosterol, β -sitosterol, stearic acid and oleanolic acid-3-O- β -D-glucoside. It is used as leafy vegetables (Tanveer *et al.*, 2013) in Eastern and North Eastern India, Bangladesh and also in Sri Lanka. It is considered as anti-viral, antibacterial, and hepato-protective. It is known for clearing heat and cooling blood, detoxicating and disinhibiting urine. It is very effective in Coughing up blood, hematuria, cold and pyrexia, measles, encephalitis B, stranguria with turbid urine, eczema, anthracis and furunculosis, venomous snake bite. (Deb *et al.*, 2018)^[17].

Amaranthus cruentus (CN: Red amaranth or blood amaranth, Tam: Poongkeerai), Family: Amaranthaceae. It is a tall annual herb topped with clusters of dark pink flowers. It is rich source of iron, calcium, magnesium, niacin, riboflavin, phytin, tannin etc. and also good source of antioxidants (Fernand *et al.*, 2012)^[19], thus considered as good leafy vegetable in India, Bangladesh, South African countries. It is good for young children, lactating mothers and for patients with constipation, fever, haemorrhage, anaemia or kidney complaints due to the presence of different phytochemicals (Mathur *et al.*, 2010 and Choudhury, 2012)^[39, 14]. It is rather diuretic. Roots are boiled with honey as a laxative for infants. The ash from the stems is used as a wound dressing and the heated leaves are used on tumours. (Deb *et al.*, 2018)^[17].

Amaranthus spinosus (CN: Prickly amaranth or Spiny amaranth, Tam: Mullukeerai), Family: Amaranthaceae. Spiny amaranth is native to tropical lowlands in Central and South America. It is good source of antioxidants, protein, vitamins, calcium, iron and vitamins. The young twigs are used as leafy vegetables in India and other South East Asian countries. High dietary fiber content improve digestive health and reduces constipation. It reduces bad cholesterol in blood and decreases risk of cardio-vascular disease and osteoporosis (Rai *et al.*, 2014).

Artemisia lactiflora (CN: White mugwort, Tam: Maasipathiri). Family: Asteraceae. Leaves and tender stems of white mugwort contain sesquiterpene lactones that stimulate digestive function, and antimalarial artemisinin and cytotoxic spiroketalenol ethers that have cancer preventing properties. (Rohini *et al.*, 2017)^[59].

Asystasia gangetica (CN: Ganges primrose, Tam: Mithikeerai). Family: Acanthaceae. Tropical violet/primrose whose tender leaves and stems are consumed as vegetable. Leaves have anti-asthmatic properties and are also a part of the herbal remedy in traditional African medicine (Koneri, *et al.*, 2006)^[36].

Bacopamoniari (CN: Thyme leaved gratiola, Tam: Neer Brahmi). Family: Scrophulariaceae. Brahmi is a perennial, creeping herb of wetlands and muddy shores. It is rich source of fibre, protein, Ca, Fe, P, Vit-C, nicotinic acid. The plant also contains brahmine, herpestatinesaponins, monnierin, hersaponin, bacosides A and B. These are the main therapeutic components of Brahmi. The leaves and the whole plant are used as leafy vegetables, table herb as well as medicinal herb. Famed in Ayurvedic medicine, brahmi has antioxidant properties. It is effective in cardiovascular diseases, epilepsy, reviving lost memory, increase memory

capacity, increase mind concentration, and reduce stress-induced anxiety. According to Ayurveda, it is bitter, pungent, heating, emetic, laxative and useful in bad ulcers, tumours, ascites, enlargement of spleen, indigestion, inflammations, leprosy, anaemia, biliousness, aphrodisiac, good in scabies, leucoderma, syphilis etc. and relieves stress (Anju, 2011)^[3].

Bacopamoniari (CN: Water hyssop, Tam: Brahmi). Family: Plantaginaceae. Whole plant of water Hyssop or Indian brahmi is cooked as a leafy vegetable. It is a reputed medicinal herb in Indian systems of medicine which is bitter, pungent, heating, emetic, laxative and useful in bad ulcers, tumors, enlargement of spleen, indigestion, inflammations, leprosy, anaemia, biliousness etc. It is a promising blood purifier and useful in diarrhea, fevers, epilepsy, increases memory capacity and concentration, and also reduces stress induced anxiety.

Bambusabambos (CN: Indian thorny bamboo, Tam: Moongil). Family: Poaceae. India has a great wealth of various naturally occurring plant drugs which have a great potential for pharmacological activities. It is highly reputed Ayurvedic medicinal tree. It is tall sized tree growing throughout India. It also occurs in Srilanka, Malaya, Peru and Myanmar. It has been proven to have great pharmacological potential with a great utility and usage as folklore medicine. It is widely used in folk medicine for its anti-inflammatory, astringent, laxative, diuretic, anti-ulcer, anti-arthritic, anti-obesity and abortifacient activities. The various chemical constituents reported in this plant are oxalic acid, chorogenic acid, ferulic acid, coumaric acid, protocatechuic acid, vanillic acid, caffeic acid, reducing sugars, resins, waxes, hydrogen cyanide (HCN), benzoic acid, diferuloylarabinoxylhexasaccharide, diferuloyl oligosaccharide, (5, 5'-di-(diferuloyl)-[α -L-arabinofuranosyl-(1 \rightarrow 3)-O- β -D-xylopyranosyl-9-(1 \rightarrow 4)-D-xylopyranose] (taxiphyllin), arginine, cysteine, histidine, isoleucine, leucine, lysine, methionine, phenylamine, threonine, valine, tyrosine, niacin, riboflavin, thiamine, betain, choline, proteolytic enzymes, nuclease, urease. Pharmacological evaluation of various parts of the plant have demonstrated antioxidant, anthelmintic, diuretic, anti-inflammatory, anti-ulcer, anti-diabetic, anti-bacterial, anti-fertility, hypothermic, anti-thyroid anti-tumour and ecobolic activities. Various phyto-pharmacological evaluations have been reported in this literature which indicates the potential of bamboo as a therapeutic agent. The leaves are antispasmodic and emmenagogue. They are taken internally to stimulate menstruation and to help relieve period pain. They are also taken to tone and strengthen stomach function; to expel worms; and have the reputation of being aphrodisiac (Kaikini *et al.*, 2013)^[32].

Basella alba (CN: Basella, Indian spinach, Tam: Kodipasalai). Family: Basellaceae. Basella is widely grown and mostly in kitchen gardens. There are two types-green *B. alba* and red *B. alba* var. *rubra*. Purplish fruit sap is used as a food coloring in pastries and sweets. The tender shoots including leaves, leaf stalk and stem are used as a cooling medicine in digestive disorders and contains antiviral substances, It has asperient, rubefacient and anticatarrhal properties, and contains antiviral substances (Lin, *et al.*, 2009), saponins, kaempferol and betalin (Moudgil, 1997)^[41] as well as steroids and phenolic compounds (Orwa, *et al.*, 2009)^[43]. In addition to proteins and fat, leaf extracts also contain vitamin A, vitamin C, vitamin E, vitamin K, vitamin B9 (folic acid), riboflavin, niacin, thiamine and

minerals such as calcium, magnesium and iron. (Deb *et al.*, 2018) [17].

Boerhavia diffusa (CN: Red Spiderling, Tam: Mookaratisaarai, Punarnava). Family: Nyctaginaceae. Red Spiderling is a prostrate herb with very diffuse inflorescences. The plant is good source of Na, Mg, Ca, Vit-C, B3, dietary fibre, antioxidants (Ujowundu *et al.*, 2008) [71] and other therapeutic chemicals like boeravinone, punarnavarine etc. (Khan *et al.*, 2013) [35]. The tender young leaves and shoots are used as leafy vegetable or table herb. Popular in Ayurveda, this herb is known for its anti-inflammatory and analgesic properties. The roots of 'Punarnava', are used by a large number of tribes in India for the treatment of various hepatic disorders. It has been used for pain relief, anti-inflammation, treating indigestion. It is effective diuretic, and can suppress the proliferation of immune cells. Its anti-proliferative effect, anti-cancerous effect and anti-diabetic effects comes from the isolated bioactive punarnavarine. (Campbell, 1987) [12].

Celosia argentea (CN: Silver Cockscomb, Tam: PannaiKeerai). Family: Amaranthaceae. Its leaves, tender stems, young flower spikes have high B-carotene, vitamin E, folic acid, ascorbic acid, iron, calcium and protein content. (Rohini *et al.*, 2018).

Centella asiatica (CN: Indian Pennywort, Tam: Vallarai). Family: Apiaceae. Indian Pennywort is a small creeping slender trailing herb especially abundant in the swampy areas of India, rooting at the nodes. The plant is good source of dietary fibre, protein, minerals and antioxidants (Upadhyay and Saikia, 2012) [72]. Different active principles like diterpenes, asiatic acid and madecassic acid and their derived triterpene ester glycosides, asiaticoside and madecassoside- β -pinene, α -terpinene, bornyl acetate, α -copaene, β -elemene, β -caryophyllene, trans- β - farnesene, germacrene-D has been isolated. The tender young leaves and shoots are used as leafy vegetable or table herb. CNS disorders like epilepsy, schizophrenia and Cognitive dysfunction. It also finds use in renal stones, leprosy and skin diseases, anorexia and asthma. In other traditional systems, it has been additionally used in the management of diarrhoea, cholera, measles, jaundice, leukorrhoea, haematemesis, hepatitis, urethritis, toothache, syphilis, smallpox, neuralgia, rheumatism, toothache and varices; and as an antipyretic, analgesic and anti-inflammatory (Arora *et al.*, 2002) [4].

Cleome gynandra (CN: Wild Spider Flower, Tam: Nalvelai, Thailvelai). Family: Cleomaceae. Spider plant (cat's whiskers), leaves possess antioxidative and anti-inflammatory properties and are used as an analgesic, particularly for headaches and earaches, a decoction or infusion of boiled leaves and/or roots is administered to facilitate childbirth, treat stomach-ache, constipation, conjunctivitis or thread-worm infection. Seeds and roots also have these anthelmintic properties. (Rohini *et al.*, 2018).

Coccinia grandis (CN: Ivy gourd, Tam: Kovai). Family: Cucurbitaceae. Ivy gourd's young leaves and long slender stem tops are eaten as protherb or added to soups. Fruits are nutritious and young and tender green fruits are used raw in salads or curries and vegetables. The juice of the roots and leaves is used for diabetes and gonorrhoea. The leaves are used as a poultice in treating skin eruptions. The plant is laxative and its extract has hypoglycaemic principles (Pareek and Samadia, 2002) [46].

Corchorus olitorius (CN: Nalta Jute, Tam: KattuThuthi, Peratti). Family: Tiliaceae. It is used as a sole or mixed green leafy vegetable. The plant has an anti-oxidant activity with a

significant atocopherol equivalent to vitamin E (Rohini *et al.*, 2018).

Cryptotaenia japonica (CN: East Asian Wildparsely). Family: Apiaceae. Tender leaves and shoots of Japanese parsely are rich in beta carotene, riboflavin, folic acid, ascorbic acid, iron. Used In the treatment of haemorrhages, colds, fevers and as a tonic for strengthening the body. (Rohini *et al.*, 2018).

Cyamopsis tetragonoloba (CN: Cluster bean, Tam: Kothavarai). Family: Leguminaceae. Pods of cluster bean are rich in ascorbic acid and folic acid, leaves are rich in, calcium, protein and used as a demulcent. Effective in lowering cholesterol, high blood pressure, and to slow down the release of sugar from the GI tract. (Parultripathi and Rajshreepandey, 2016) [47].

Licium chinense (CN: Chinese Boxthorn). Family: Solanaceae. Young leaves with petioles and young inflorescence are consumed. Leaves of chinensis boxthorn are rich in B-carotene, vitamin E, folic acid, ascorbic acid, calcium, iron and protein (3-6%). Fruits improve eyesight and enhance the immune system. (Rohini *et al.*, 2018).

Diplazim esculentum (CN: Vegetable fern). Family: Athyriaceae. Young fronds of lungru are eaten by the tribals either as salad or as green vegetable after frying, boiling or cooking. It probably the most commonly consumed fern, and is quite tasty, giving it the name "vegetable". It is rich in micronutrients, especially iron, manganese and zinc and is used in curry in various forms, as cooked and pickle (Padulosi, *et al.*, 1999) [44].

Enhydra fluctuans (CN: Water Cress). Family: Asteraceae. A trailing marsh herb, also floating on water. Plant is rich in protein and is a good source of β -carotene. It also contains saponins, myricyl alcohol, kaurool, cholesterol, sitosterol, glucoside, sesquiterpene lactones including germacranolide, enhydrin, fluctuanin and fluctuandin, a number of diterpenoid acids and their isovalerate and angelate derivatives, stigmaterol, cholesterol, sitosterol, glucoside, other steroids. The plant is considered as antidiabetic, antimicrobial, antiinflammatory, antioxidant, anticancerous, haepatoprotective, neuroprotective, analgesic etc. Leaves are laxative and antibilious; cure inflammation, leucoderma, bronchitis and biliousness; useful in skin and nervous affections; also useful in tropidity of the liver (Sarma *et al.*, 2014) [58].

Eryngium foetidum (CN: Long Coriander, Tam: Piranga). Family: Apiaceae. Spiny or serrated coriander whose leaves are rich in calcium, iron, carotene, and riboflavin. Leaves and roots are used in tea to stimulate appetite, improving digestion, soothe stomach pains, as an expectorant and aphrodisiac.

Fagopyrum sp. (CN: Buck Wheat, Tam: Marakothumai, Papparai). Family: Polygonaceae. Leaves and young shoots of *Fagopyrum esculentum* (bucketwheat) and *F.tataricum* (duckwheat, Indian buckwheat, kaspai) are eaten as spinach and potherb. It contains rutin, which reduces haemophilia and heart attack chances. (Rohini *et al.*, 2018).

Glinus oppositifolius (CN: Bitter Cumin Leaf). Family: Molluginaceae. Bitter cumin or Indian Chick weed is a weedy plant found throughout the tropical and subtropical countries. Stems are prostrate or rising, up to 15-20 cm long or more, smooth, thin, sometimes pigmented. Leaves are flat, elliptic to obovate, 1-2 cm long, 0.4-1 cm wide, light green. White flowers are borne solitary and axillary. Seeds ovoid, curved, tubercled, dark reddish brown. It is rich in vitamins, antioxidants and minerals. Different parts of this plant are traditionally used in joint pain, inflammation, diarrhoea,

fever, boil. It is analgesic and antimicrobial, anthelmintic, stomachic, appetizer, antiseptic, hypoglycaemic, hypolipidemic and haepatoprotective (Hoque *et al.*, 2011 and Chhanda *et al.*, 2014) [24, 13].

Gmelina arborea (CN: Gamhar, Tam: Kumilmaram). Family: Verbenaceae. Young tender leaves of white teak are used as vegetable. The root and bark are stomachic, galactagogue, laxative and anthelmintic; improves appetite; useful in hallucination, piles, abdominal pains, burning sensations, fevers, 'tridosha' and urinary discharge. Leaves are used to relieve headache and as wash for ulcers. Flowers and sweet, cooling, bitter, acrid, astringent and are useful in curing leprosy and blood disease. (Rohini *et al.*, 2018).

Hibiscus sabdariffa (CN: Roselle, Tam: Sempulichai). Family: Malvaceae. Popularly known as roselle. Young shoots and leaves are astringent, antiscorbutic, emollient, diuretic, sedative, emollient. Used as a folk remedy in treatment of abscesses, bilious conditions, cancer, cough, debility, dyspepsia, disuria, fever, hangover, heart ailments, hypertension, neurosis, and scurvy; Fresh or dried calyxes are used in preparing chutney, jellies, and sauces. Tender leaves and stalks are eaten as a vegetable. Mature leaves are consumed as a vegetable (Haq, 1984) [22].

Houttuynia cordata (CN: Chameleon plant, Tam: MeenPuthina). Family: Saururaceae. Saururus tender shoots, leaves and rhizomes are consumed raw or cooked as apotherb. Have anti-bacterial, anti-viral, anti-inflammatory, antimicrobial, anti-philogistic, depurative, diuretic, emmenagogue, febrifuge, hypoglycaemic, laxative and ophthalmic properties. A decoction is used in the treatment of cancer, coughs, dysentery, enteritis and fever. (Rohini *et al.*, 2018).

Hydrocotyle sibthorpioides (CN: Indian pennywort). Family: Araliaceae. The plant has long creeping stems (about 1.5 ft) that often form dense mats, often in and near ponds, lakes, rivers, marshes. It is good source of minerals and vitamins. Besides stigmasterol, daucosterol, hibalactone, genistein, daidzein, methyl-3, 4-dihydroxybenzoate, protocatechuic acid, caffeic acid, isorhamnetin, quercetin, hyperinetc are present in this plant. Used mainly as leafy herbs as salad or cooked by the tribes of Eastern and North Eastern India. The juice of the plant is emetic. It is considered as depurative, febrifuge, expectorant, antitussive, antifebrile, diuretic and anticancerous. It has also antimicrobial property. (Huang *et al.*, 2008) [26].

Hygrophila auriculata (CN: Marsh barbell, Tam: NeerMulli). Family: Acanthaceae. Marsh Barbel is a stout aquatic perennial herb. The plant is rich source of Fe, Ca, P, Na, vitamins, antioxidants, polyphenols, flavonoids, proanthocyanins, alkaloids, enzymes, amino acids, hydrocarbons, terpenoids, glycosides etc. (Hussain *et al.*, 2010; Bibu *et al.*, 2010 and Dattatrya *et al.*, 2012) [10, 21] It is extensively used in the treatment of diseases of urinogenital tract, hyperdipsia, vesical calculi, flatulence, diarrhea, dysentery, leucorrhoea, gonorrhoea, asthma, blood diseases, gastric diseases, painful micturition, menorrhagea, rheumatism, inflammation, jaundice, hepatic obstruction, pain, etc. (Deb *et al.*, 2018) [17].

Lactuca indica (CN: Indian lettuce, Tam: ShallattuVirai). Family: Asteraceae. Popularly known as Indian lettuce, whose leaves and tender stems are used as salad, boiled, steamed or used in soups. Plant is digestive and tonic, used for its anodyne, antispasmodic, digestive, diuretic, hypnotic, narcotic and sedative properties. (Rohini *et al.*, 2018).

Leucas aspera (CN: Common leucas, Tam: Thumbai), Family: Lamiaceae. Common Leucas is an erect and diffusely branched annual herb. The plant is a good source of Vit-A, Ca, Fe, P, Zn and dietary fibre. It also contains various phytochemical constituents mainly triterpenoids, oleanolic acid, ursolic acid and b-sitosterol, nicotine, sterols, glucoside, diterpenes, phenolic compounds etc. It is used as leafy vegetables only after cooking and also as medicinal herb (Vijayanthi and Doss, 2015) [73] mostly by the tribal peoples of North Eastern India. It has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive and cytotoxic activity. It is commonly used to treat nasal congestion, coughing, cold, headache and fever. In addition the juices of the flower can be extracted and used to help treat sinusitis, as well as headaches. (Srinivasan *et al.*, 2011) [66].

Malva verticillata (CN: Chinese Mallow). Family: Malvaceae. Chinese Mallow is an annual or biennial that grow up to 1.7 m. Stem is green to purplish hairy, or hairless. Leaves are usually round in outline, 3-23 cm long, 4-25 cm broad, heart-shaped or flat at base, both surfaces hairy, usually 5 lobed. Flowers are borne in leaf axils, 2 to many, in loose or compact cluster. It is good source of bio-flavonoides, polysaccharides, protien, minerals and vitamins. Leaves and soft twigs are used as vegetables in India and South East Asian countries and China. It is very popular leafy vegetable Eastern Himalayan foot hills. The plant is used in the treatment of renal disorders, the retention of fluids, frequent thirst and diarrhoea The root is used to cause vomiting in the treatment of whooping cough. The leaves and stems are said to be digestive, anti-inflammatory agent. It is also known to lower the blood sugar and relief the constipation. (Tekley *et al.*, 2013).

Morindacitrifolia (CN: Noni, Tam: Nuna). Family: Rubiaceae. Young leave and terminal buds of Indian mulberry are used as vegetables; unripe fruits are cooked, ripe fruits consumed raw. Leaves, flowers, fruit, bark used to treat eye problems, skin wounds, gum and throat problems, respiratory ailments, constipation, fever, stomach pains, juice of leaves taken for arthritis, fruits consumed for asthma and dysentery and the plant is also known to treat diabetes and venereal diseases (Phadungkit, *et al.*, 2012) [49].

Moringa oleifera (CN: Moringa, Tam: Murungai). Family: Moringaceae. Drumsticks, or 'Horse radish tree', are rich in vitamin A and C, mineral packed (calcium, phosphorus and iron) highly nutritious perennial vegetable (Pradheep, *et al.*, 2003) [50]. Leaves flowers and immature pods are used in various vegetable dishes, curries, pickle, powder and flesh mesocarp powder. 30 g of leaf powder can cover one-third of the daily allowance for proteins, 75% of the calcium needs, and more than half of the iron necessary for children under three years of age (Rai, *et al.*, 2005) [52].

Nasturtium officinale (CN: Water cress). Family: Brassicaceae. Commonly called watercress whose tender shoots and leaves are exceptionally rich in vitamin C, folic acid, ascorbic acid and minerals, especially iron and used in soups, salad or as a garnish. A detoxifier, antiscorbutic, diuretic and stimulant. (Rohini *et al.*, 2018).

Neptunia oleracea (CN: Water mimosa, Tam: Sundaikirai). Family: Mimosaceae. Water mimosa whose young shoots are consumed raw, cooked or stirfried and are rich in iron, calcium and protein (6.4%). Used in the treatment of yellow fever, guinea worm infection, earache and syphilis. (Rohini *et al.*, 2018).

Nymphaea odorata (CN: American white water lily, Tam: Alli). Family: Nymphaeaceae. Stems, young leaves, lower buds, flower stalks and rhizomes of water lily are used as vegetables. The rhizomes are cooling, sweet, better and tonic useful in treating diarrhea, dysentery, dipsia and general debility. The flowers are astringent and cardiogenic. The seeds are sweet, cooling, constipating, aphrodisiac, stomachic, restorative, also used as a treatment for gastrointestinal disorders and jaundice (Jana, 2007) [30].

Oenanthe javanica (CN: Water celery, Tam). Family: Apiaceae. Tender stems and leaf stalks of water celery are used fresh as salad, garnish or chopped as greens. Leaves used as depurative, febrifuge and styptic, decoction used in treatment of epidemic influenza, fever, discomfort, and jaundice and applied externally as a poultice for poisonous bits, abscesses, and malignant swellings. (Rohini *et al.*, 2018).

Oxalis corniculata (CN: Creeping wood sorrel, Tam: Puliyaarai). Family: Oxalidaceae. Oxalis is good source of flavanoids, tannins, phytosterols, phenol, glycosides, fatty acids, galactoglycerolipid and volatile oil. The leaves contain flavonoids, isovitexine and vitexine-2-O- β -D-glucopyranoside and other different antioxidants (Kumar *et al.*, 2012) [37]. It is rich source of essential fatty acids like palmitic acid, oleic, linoleic, linolenic and stearic acids and it possesses important. It is used as leafy vegetables and salad herb. Activities like antioxidant, Anticancer, anthelmintic, Anti-inflammatory, Analgesic, Steroidogenic, Antimicrobial, Antiamoebic, Antifungal, Astringent, Depurative, Diuretic, Emmenagogue, Febrifuge, Cardio relaxan, stomachic and Styptic have also been reported. These reports are very encouraging and indicate that herb should be studied more extensively for its therapeutic benefits (Raghavendra *et al.*, 2006; Sharma and Kumari, 2014) [51, 62].

Perilla frutescens (CN: Perilla). Family: Lamiaceae. Young leaves and shoots rich in iron, calcium and protein (6.4%). Has anti-allergic, anti-carcinogenic, anti-inflammatory, antioxidative, anti-asthmatic, anti-bacterial, antidote, antimicrobial, anti-pyretic, antiseptic, anti-spasmodic, carminative, diaphoretic, emollient, expectorant, stomachic and tonic properties (Rohini *et al.*, 2018).

Piper mulesua (CN: Hill pepper, Tam: Kattukurumulagu, Kattuthippali). Family: Piperaceae. Young tender leaves of paharipeepal are used as vegetables. Dried plant is consumed to cure malaria and cough disease. Roots and fruits are in Ayurvedic medicines. (Rohini *et al.*, 2018).

Pisonia grandis (CN: Tree lettuce, Tam: Latchakkottaikerai). Family: Nyctaginaceae. Tree lettuce leaves are used as diuretic and also for diabetics. (Rohini *et al.*, 2018).

Polygonum plebeium (CN: Knot weed). Family: Polygonaceae. It is a gregarious low trailing herb that quickly covers the ground. It is native to the Himalayas, Kashmir to Bhutan. It is a good source of protein, fibre and minerals like Ca, Mg, K, Fe etc. Besides it is a good source of antioxidants. The young twigs are used as leafy vegetables mostly by tribal peoples (Deshmukh and Rothe, 2013) [18]. It is used in colic complaints and eczema. Leaves are known to be used in cure of pneumonia and having other medicinal values (Hamid *et al.*, 2008) [21].

Portulaca oleracea (CN: Purslane, Tam: Paruppukeerai). Family: Portulacaceae. Purslane can be found growing in cold climate areas as well as warm areas. It contains considerable amount of Fe, Ca, Zn, Vit-A, riboflavin, folic acid, flavonoids etc. (Srinivasa *et al.*, 2008) [65]. It has been used in salads, cooked vegetables and as a medicinal plant (for people) for hundreds of years Purslane is a good edible and is eaten

throughout much of Europe and Asia. Since it has a mucilaginous quality it is great for soups and stews. It is reported to be used as diuretic, sedative, analgesic, cardiogenic. It is also used to treat rheumatism, gynaecological diseases, renal and colorectal diseases (Hughes, *et al.*, 2013) [27].

Rumex sp. (CN: Docks or sorrels or KhattaPalak, Tam: Sukkankeerai). Family: Polygonaceae. Species such as *R. acetosella*, *R. hastatus*, *R. patentia* and *R. scutatus* are mostly consumed raw. They have astringent and slightly purgative qualities. The leaves of *R. dentatus* are rich in calcium, carotene, and vitamin C and form a nutritious vegetable (Indira and Peter, 1988) [29].

Sauropus androgynous (CN: Multivitamin green, Tam: Thavasikerai). Family: Phyllanthaceae. Juice of leaves of chekkurmanis pounded with roots of pomegranate and leaves of jasmine is used against eye diseases. The tendershoots and leaves are used for culinary purposes. (Rohini *et al.*, 2018).

Sesbania grandiflora (CN: Vegetable hummingbird, Tam: Agathi). Family: Fabaceae. Agathi is widely distributed in India. The tender leaves, green fruit and flowers are eaten as vegetable or curries or salads. It is aperients, diuretic, emetic, emmenagogue, febrifuge, laxative, tonic and its folk remedy for bruises, catarrh, dysentery, eyes, fevers, headaches, smallpox, sores, sore throat, stomatitis and night blindness (Ravishankar, *et al.*, 2009) [55].

Solanum indicum (CN: Black Nightshade, Tam: Mull Kathiri). Family: Solanaceae. Half ripe fruits of bush tomato are used in the preparation of curries, paste or pickles. Leaves are used as vegetable. Fruits are digestive but more quantity is considered toxic due to presence of solasodine. Fruits are eaten to cure dysentery, gastritis, malaria and indigestion due to high alcohol consumption. (Rohini *et al.*, 2018).

Solanum spirale (CN: Spiral nightshade). Family: Solanaceae. Tender fruits and leaves are used as vegetable. Green fruits are eaten, especially during malaria outbreak. The dried ripe fruits are used (sole or mixed) for stomach pain and gastric problem. (Deb *et al.*, 2018) [17].

Sphenoclea zeylanica (CN: Goose weed). Family: Campanulaceae. Leaves and the young shoots are eaten as vegetables which are a rich source of B-carotene and ascorbic acid. Leaves are used in a poultice against the stings of venomous animals and to cure the ulcers. (Rohini *et al.*, 2018).

Trianthema portulacastrum (CN: Horse Purslane, Tam: Saranai, Saranathi, Vensaranai). Family: Aizoaceae. Horse Purslane is a weed found throughout the tropical and subtropical countries. It occurs in wastelands, roadsides, lawns, gardens and also in cultivated crop field. It is rich in Vit-A, Fe, Ca, P etc. Major therapeutic compositions are ecdysterone, trianthemol, 3-acetylauritolic acid, 5,2'-dihydroxy-7-methoxy-6,8-dimethylflavone, leptorumol, 3,4-dimethoxy cinnamic acid, 5-hydroxy-2-methoxybenzaldehyde, p-methoxybenzoic acid, and beta cyanin. Different parts of this plant are traditionally used as analgesic, diuretic, stomachic, laxative, antimicrobial (Kavitha *et al.*, 2014) [34] treatment of blood disease, anaemia, inflammation, and night blindness. The roots have cathartic and stomachic properties and used to relieve obstructions of liver and asthma, reduces hepatotoxicity, hepatocarcinogenicity (Sharmila Banu *et al.*, 2009) [63]. The leaves are diuretic and are applied in the treatment of oedema, jaundice, painful discharge of urine, rheumatism, gonorrhoea, venereal discharge and dropsy.

Trichosanthes dioica (CN: Pointed Gourd, Tam: Kambupudalai). Family: Cucurbitaceae. Pointed gourd has been used for overcoming problems like constipation, fever, skin infection, wounds and also improves appetite and digestion. The immature fruits are used as vegetable and as ingredients of soups, stew, curry, sweet, or eaten fried and as dorma with rose stuffing. (Rohini *et al.*, 2018).

Trigonella balansae (CN: Indian Fenugreek). Family: Leguminosae. It is a perennial herb. It is rich source of protein, vitamins, antioxidants and Ca. It is used as leafy vegetables in young stages in Eastern India. It is considered as body coolant and used in kidney and liver problem. (Deb *et al.*, 2018) [17].

Typhonium trilobatum (CN: Bengal arum, Tam: Kattukarunaikilangu). Family: Araceae. It is a tuberous herb. The leaves of the plant is rich source of Fe, Vit-C, Ca, bioflavonoides, antioxidants (Banerjee *et al.*, 2015) [8]. The leaves are used as leafy vegetables and the corms are used as vegetables and medicine purpose. The plant is proved as analgesic, anti-diarrheal, anti-inflammatory, antibacterial (Roy *et al.*, 2013) [57]. Tubers and roots contain a volatile acrid principle, β -sitosterol, two unidentified sterols and an unidentified crystalline compound. The whole plant is highly antibacterial. The plant is used in piles, tumor, skin diseases, diarrhoea etc. (Deb *et al.*, 2018) [17].

Urtica dioica (Cn: Common Nettle, Tam: Peru-n-kanchori). Family: Urticaceae. It is used in a variety of vegetables and herbal medicine. Young leaves are edible and make a very good pot-herb. It is used in anti-itch drugs, creams containing antihistaminics or hydrocortisone. (Rohini *et al.*, 2018).

Conclusion

Evidence from many epidemiological studies and clinical trials shows that the vegetarian diet is associated with many positive health outcomes such as reduced risk of various chronic illnesses, reduced overall mortality, and increased likelihood of healthy aging (Tuttolomondo *et al.*, 2015). Numerous preclinical studies carried out in recent years have identified beneficial protective and enhancing effects of vegetables on health, resulting from the nutritional and non-nutritional phytochemical contents of vegetables. One of the most important features of these diets is the high consumption of leafy vegetables having more fiber, vitamins, minerals, flavonoids, phytoestrogens, sulfur compounds, phenolic compounds such as monoterpenes and bioactive peptides, which have positive effects on health (Septembre-Malaterre *et al.*, 2018) [60]. These phytochemicals have the ability to modify the cellular function by modulating transcription factors and altering gene expression, cellular metabolism, and cellular signaling. The World Health Organization (WHO) recommends daily intake of 5–8 portions (400–600 g) of fruits and vegetables to reduce the risk of micro nutrient deficiency, cardiovascular diseases, cancer, cognitive impairment, and other nutritional health risks. In order to make optimum use of the nutritional content of leafy vegetables, choosing the right methods of preparation and cooking is as important as the consumption of adequate amounts of leafy vegetables. To minimize nutritional losses, greens should be chopped right before cooking.

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