Significance of vegetables in human diet—A short review

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ABSTRACT
Vegetables are important food and highly beneficial for the maintenance of health and prevention of diseases. Vegetables contribute minerals, vitamins and fiber to the diet. Vegetables are classified as leaf, stem, fruit, flower, root etc. Some vegetables are also seasonal and have their own nutrition value. Vegetables are not only store house of many nutrients. They also signify therapeutic value and show antioxidant properties. The vital metals are transferred into our bodies through vegetables which absorb them from soil. The demand for vegetables is increasing every year but, at the same time cultivable land is also diminishing. With a shorter shelf life, the vegetables exhibit concern about food safety. It is the need of the hour to enhance the production and improve/modify the nutrient status of vegetables through biotechnological approaches.

INTRODUCTION
Vegetables are the fresh and edible portions of herbaceous plants. They are important food and highly beneficial for the maintenance of health and prevention of diseases. They contain valuable food ingredients which can be successfully utilized to build up and repair the body. Vegetables are valuable in maintaining alkaline reserve of the body. They are valued mainly for their high carbohydrate, vitamin and mineral contents. There are different kinds of vegetables. They may be edible roots, stems, leaves, fruits or seeds. Each group contributes to diet in its own way[1]. Vegetables contribute minerals, vitamins, and fiber to the diet. Minerals are naturally occurring inorganic substances with a definite chemical composition and an ordered atomic arrangement[2]. Out of 92 naturally occurring minerals 25 are present in living organisms. They are constituents of bones, teeth, blood, muscles, hair and nerve cells. Vitamins cannot be properly assimilated without the correct balance of minerals[3].

People should consume several hundred grammes of plant-based diet a day since it is a good source of nutrients and dietary fiber. A plant-based diet—focusing mainly on vegetables, fruits and whole grains has become one of the most important guidelines for lowering the risk of human diseases. Therefore, there is a need to improve the nutritive value of the final product of vegetable plant. The important contribution of the nineteenth Century, experimental plant physiology to agriculture was the discovery that soil fertility and crop yields could be increased by adding several nutrients to the soil.
Even though crop plants require micronutrients in very minute quantities, their deficiencies may affect fundamental physiological and biochemical processes, leading to drastic reductions in yield\[^{[4]}\].

**Definition**

A vegetable is the edible portion of a plant. Vegetables are usually grouped according to the portion of the plant that is eaten such as leaves, stem, roots, tubers, bulbs and flowers, it was specified to mean plant cultivated for food, it is herbaceous plant or its part, intended for cooking or eating raw. In biological terms, ‘Vegetable’ is designated member of the plant kingdom\[^{[5]}\].

**CLASSIFICATION OF VEGETABLES**

Vegetables are classified into green vegetables and root vegetables. Green vegetables include leaf, stem, fruit and flower portions, and root vegetables are root, bulb, tuber portions etc. This classification is done on the basis of nutrient also\[^{[6]}\]. Classification of vegetables is given in TABLE-1.

**TABLE 1 : Different classes of vegetables by Nutrient supply**

<table>
<thead>
<tr>
<th>Class</th>
<th>Vegetables</th>
<th>Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green vegetables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf vegetables</td>
<td>Beet, cabbage, chicory, salad greens, spinach</td>
<td>DF, V, M</td>
</tr>
<tr>
<td>Stem vegetables</td>
<td>Asparagus, cardoon, celery Artichoke, eggplant</td>
<td>V, M</td>
</tr>
<tr>
<td>Fruit and flower Vegetables</td>
<td>cauliflower, zucchini, cucumber, mushroom, pepper, tomato, okra</td>
<td>DF, V, M</td>
</tr>
<tr>
<td>Root vegetables</td>
<td>Beet, carrot, 'fennel, onion, potato, radish, turnip</td>
<td>DF, CC, V, M</td>
</tr>
</tbody>
</table>

Where, CC: complex carbohydrates; DF: dietary fiber; M: minerals; V: vitamins

Many nutrients are present in vegetables like carbohydrates, protein, fat, vitamins, minerals, water etc\[^{[7]}\]. In which amount it is present per 100g given in TABLE-2.

**THERAPEUTIC VALUE OF VEGETABLES**

Vegetables have been used in many parts of the world for hundreds of years as herbal medicines with broad ranges of nutritional and therapeutic values. The non-nutrient phytochemicals may contribute to the normal functioning of the human body. The antioxidant composition and capacity of vegetables and fruits relative to intake data are important to understand the health implications of various dietary patterns. It has been reported that vegetables ranked in the top ten in an antioxidant assay included sweet potato leaf, ginger, amaranth, spinach, eggplant, leafy Chinese cabbage, tomato, onion\[^{[8]}\]. Some vegetables and therapeutic value are given (TABLE- 3).

**DEFICIENCY DISORDERS**

Recent studies indicate that consumption of adequate amounts of vegetables may have disease-preventive properties. Vegetable consumption has been associated with a lower risk of heart disease and other health conditions and continues to be an important part of a healthy diet. Diets rich in fruits and vegetables may reduce the risk of ischemic stroke. Cruciferous vegetables such as broccoli and spinach seem to provide the greatest benefit. High blood pressure is a primary risk factor for heart disease and stroke. A diet rich in fruits, vegetables, and low-fat dairy products restricted in the amount of saturated and total fat can be a very effective tool for lowering blood pressure\[^{[8,9]}\].

**TABLE 2 : Mean chemical composition of vegetables**

<table>
<thead>
<tr>
<th>Minerals</th>
<th>Vitamins</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (g) 79-96</td>
<td>Ca (mg) 10-170</td>
<td>(\beta)-carotene (mg) 0.1-5.0</td>
</tr>
<tr>
<td>Protein (g) 0.5-5.0</td>
<td>P (mg) 12-125</td>
<td>C (mg) 3-230</td>
</tr>
<tr>
<td>Fat (g) 0.1-1.0</td>
<td>Fe (mg) 0.2-8.0</td>
<td>(Kcal) 10-85</td>
</tr>
<tr>
<td>Carbohydrate (g) 0.5-18.0</td>
<td>Na (mg) 2-150</td>
<td>(Kj) 42-356</td>
</tr>
<tr>
<td>Dietary fiber (g) 0.8-8.0</td>
<td>K (mg) 200-600</td>
<td>B6 (mg) 0.1-0.2</td>
</tr>
</tbody>
</table>
Vegetable Therapeutic value

**Beet**
- Arginine, betaine, histidine, isoleucine, leucine, phenylalanine, tyrosine, and tyrosinase betaine, cadmium, caffeic acid, calcium, carbohydrates, β-carotene, chlorogenic acid, chromium, citric acid, copper, p-coumaric acid, cystine, daucic acid, farnesol, fat, ferulic acid, folacin, formaldehyde, glutamic acid, glycine, kaempferol, leucine, linoleic acid, α-linolenic acid, lithium, lysine, magnesium, manganese, mercury, molybdenum, niacin, nitrogen, ornithine, oxalic acid, oxycitronic acid.
- It used as a folk cancer remedy in Arabian, American, German, and Mexican medicine. Contains folic acid and glucosinolates.
- Antioxidative and antimutagenic activities of polyphenols have been isolated from broccoli.

**Broccoli**
- Especially sprouts, also has the phytochemical sulforaphane, a product of glucoraphanin, which is believed to aid in preventing some types of cancer.
- The antioxidative effect and protective potential against diabetes of the broccoli flower were investigated in vitro and in a diabetic rat model.
- Rich in minerals, especially potassium and vitamins A, B6, and C.
- Antidiarrheic, antiscorbutic, and antiseptic ethylamine, ferulic acid, fiber, fluoride, folacin, clucobener, glutamic acid, glycine, iron, isomethanol, kaempferol, leucine, alpha-linolenic acid, luten, lysine, magnesium, maleic acid, manganese, menthol, mevalonic acid, niacin, nitrogen, oleic acid, oxalate, palmitic acid.
- Used to treat gastritis, gastric and duodenal ulcers, gastric pain, gastric hyperacidity, and Roemheld syndrome.
- Rich in carotenoids, the main constituents are pyrroline, dyacine, and daucosterine.
- Its essential oil has limonene, pinene, and cineole.

**Carrot**
- It is used as a diuretic, to lower blood sugar, for prevention of cancer, and to treat diabetes, heart disease, dyspepsia, gout, and carcinomatous ulcers, amenorrhea, angina, asthma, diarrhea, high blood pressure, high cholesterol, liver and skin problems, and wrinkles.
- Carrot has been reported to exert low antioxidant activity compared with other vegetables.
- Rich in minerals, especially potassium, and vitamin C.
- It is used as a tonic and assists digestion.

**Cabbage**
- It contains alpha- and beta-amyrin, ascorbic acid, aspartic acid, caffeic acid, alpha- and betacarotene, cinnamic acid, citric acid, fumaric acid, glucoroein, glucoberin, glutamic acid, phydroxybenzoic acid, indole-3-carboxylic acid, linoleic acid, maleic acid, methanol, molybdenu, neoglucobrassicin, palmitic acid, pantothenic acid, phytoesters, quercitin, quinic acid, selenium, silicon, stigmasterol.
- Radish leaves usually are medium green and lobed and have a rough texture.
- The leaves are popular in China and are used as a vegetable.
- It has a fair amount of vitamins B and C as well as pectin, phyton, iron, manganese, and copper.
- It is used to treat asthma, cough, diarrhea, dysentery, and malnutrition stomach cancer, diabetes, windpipe infection, constipation, blood pressure, and chronic cough.
- It contains feric acid, gentisic acid, raphanusr, erucic acid, glycerol, sinapate, raphanin, and Sulforaphen.
- High contents of potassium and phosphate.
- Leaves are used for internal hemorrhages; fruit is an antidote for poisonous mushrooms; root is an astringent for bladder flux, entheregia, and hematuria.

**Cauliflower**
- Rich in minerals, especially potassium and vitamin C.
- It is used as a tonic and assists digestion.
- It contains alpha- and beta-amyrin, ascorbic acid, aspartic acid, caffeic acid, alpha- and betacarotene, cinnamic acid, citric acid, fumaric acid, glucoroein, glucoberin, glutamic acid, phydroxybenzoic acid, indole-3-carboxylic acid, linoleic acid, maleic acid, methanol, molybdenu, neoglucobrassicin, palmitic acid, pantothenic acid, phytoesters, quercitin, quinic acid, selenium, silicon, stigmasterol.
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**Eggplant**
- Eggplant has been reported to be a treatment for rheumatism, cardiovascular illnesses, obesity, high cholesterol, and constipation.
- It is also a digestive aid, diuretic, sedative, and calming, with the ability to relieve colic, reduce stomach ulcers, and serve as a stimulant for the liver and intestines.
- It contains solanine, solasonins, solamargine, solasodine, diosgenin, and tigogenin.
- Used in folk medicine to treat asthma, bronchitis, burns, cancer, fever, insomnia, sclerosis, sores, and swellings.
- It contains alanine, arginine, arsenic, ascorbic acid, delta-5-avenasterol, cadmium, caffeic acid, betacarotene, chlorine, p-coumaric acid, ergosterol, ferulic acid, folic acid, glycine, histidine, isoleucine, kaempferol, betalactucerol, lactuc, lactucopirci, lanthanum, alphanolinic acid, lysine, molybdenu, oleic acid, oxalic acid, palmitic acid, palmoliteic acid, pantothenic acid, prolin, quercetin, selenium, sitosterol, stearic acid, stigmasterol, tryptophan, tyrosine.
- Contains saponin, saponarein, and vitexin.
- The leaf is high in calcium, fiber, niacin, and vitamins A and C.
- Leaves are used for their stomachic, diuretic, and expectorant properties. Stem, bark, and root are used to treat diarrhea, dysentery, dysmenorrhea, itching, and painful skin diseases.

**Lettuce**
- Contains saponin, saponarein, and vitexin.
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- Leaves are used for their stomachic, diuretic, and expectorant properties. Stem, bark, and root are used to treat diarrhea, dysentery, dysmenorrhea, itching, and painful skin diseases.
- A root bark decoction is used to treat dermatophytosis. The decoction is a vermifuge and is hemostatic, antiphlogistic, and emollient. The decoction is used to treat amebic dysentery and colitis and is applied externally to piles. It is also used to treat ascariasis, dysentery, dyspepsia, enterorrhagia, leucorrhoea, and nausea.
**Vegetable** | **Therapeutic value**
--- | ---
Onion | Onion has bacchic, emmenagogue, and diuretic properties. The fresh juice has been found to contain a hypoglycemic agent. It is regarded as alternative, resolvent, and vulnerary. It is used to treat chest colds, shortness of breath, headache, and stomach and intestinal troubles. Onion contains throb, methyl disulfide, trisulfide, thiosulfonates, citrate, malate, polysaccharides A and B, quercetin, thymine, kaempferol, carotenes, and 0-coumaric, caffeic, ferulic, sinapic, p-coumaric. Onion has been medicinally for centuries as an external antiseptic. It may be helpful in allaying intestinal gas pains; in reducing hypertension, high blood sugar, and the cholesterol and fat content of the blood; and in relieving pain and inflammation. It is used both raw and cooked.
Pea | Contains vitamins A, B, and C, lecithin, cholesterol, betaine, trigonelline, choline, adenine, lysine, erepsin, leucine, arginine, tryptophan, phytin, vernin, asparagine, glutamine, alantoinase, urea, pepsin, trypsin, amylase, maltase, catalase, lipase, nuclease, phytagglutinin, ascobic acid, and gibberellin A. It is one of the better sources for choline, which may prevent liver cancer.
Sweet corn | Both carotenoids and tocopherols can be found in corn kernel tissue. These compounds are associated with the prevention of degenerative diseases. Corn silks are used as a diuretic in dropsy and to treat sugar diabetes.
Sweet potato | The Chinese have used corn silk successfully to treat swelling caused by kidney disease, according to pharmacognosists.
Tomato | The plant is herbaceous, an aquatic annual with hollow stems and ovate to elliptic shaped leaves. It has a creeping growth habit but may grow erect in water.
Turnip | The plant contains antioxidative components, including chlorogenic acid, isochlorogenic acids, and caffeic acid. The effective antioxidant activity is mainly based on the synergistic effect of phenolic compounds with amino acids.

**DAILY INTAKE OF METALS BY HUMAN BEINGS FROM MIXED VEGETABLE**

Some amount of daily intake of metals by human beings from mixed vegetables. The intake values are calculated by taking the average value of metals in all the eight varieties of the vegetables and considering that each person (assuming 70 kg of body weight) consumes approximately 300 g (WHO 1998) of vegetables per day. Hence different vegetables are consumed variably by different segment of population at different time throughout the year, so it may be a realistic estimate for the average intake of metals from vegetables. It may be intake of toxic metals except Mn, Zn and Cd from vegetables is not high and within the per-
Vegetables can become contaminated by biological hazards, such as pathogenic organisms including bacteria, viruses and parasites, chemical hazards, and physical hazards. These hazards have all caused illness or injury in fresh produce. Measures to avoid such contamination have been encouraged. The general level of hygiene in handling fruit and vegetables is also a major problem contributing to cross-contamination from animal products as well as direct contamination from the food handler. Prevention of contamination is the most efficient way to ensure food safety and prevent food borne illness[12].

### VEGETABLES PRODUCTION DATA

On an average the area under total vegetables cultivation is grown at the rate of 4.12%. The highest area growth rate was found for onion. All vegetables area is grown positive except sweet potato in which it was negative. Similarly, on an average total vegetables production growth rates was 6.48%. The highest production growth rate was found for onion. All vegetables production growth rates was more

### Food safety hazards in vegetables

Vegetables can be contaminated with a range of microbial and chemical contaminants. Vegetables eaten raw, as well as food of animal origin, have long been known to serve as vehicles for transmission of infectious microorganisms in developing countries. In contrast, the number of confirmed cases of illness associated with consumption of raw fruit and vegetables in industrialized countries has been relatively low compared to the number due to foods of animal origin. Factors thought to influence the occurrence and epidemiology of these diseases include the quality of irrigation water, and other agronomic practices such as the inappropriate use of manures and biosolids[11]. In order to reduce this risk and to increase produce safety many hazards are used it as under.

### Table 4: Some examples of deficiency disorders protected by different vegetables

<table>
<thead>
<tr>
<th>Name of Disorder</th>
<th>Vegetables use to protect disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artery hardening</td>
<td>Sweet potato vine, Onion</td>
</tr>
<tr>
<td>Asthma</td>
<td>Chinese artichoke, Chinese radish, Ducks tongue grass, Horseradish, Lettuce, Indian lettuce, Parsnip, Pepper, Sweet basil, Watercress</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Celery, Chayote, Tomato, Broccoli, Prickly pear cactus, Yellow rattan palm, Rhubarb, Tomato</td>
</tr>
<tr>
<td>Blood sugar</td>
<td>Carrot, Chinese wolfberry</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>Chinese spinach, Lettuce, Indian lettuce, Nightblooming cereus, Parsnip</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>Common bracken, Alfalfa sprout, Rhubarb</td>
</tr>
<tr>
<td>Intestinal disorder</td>
<td>Ceylon spinach, Lily bulb, Onion, Green onion, Rhubarb</td>
</tr>
<tr>
<td>Cardiovascular-disease</td>
<td>Broccoli, cabbage, cantaloupe, guava, leafy greens, pepper, potato, tomato</td>
</tr>
<tr>
<td>Heart disease</td>
<td>Dark-green vegetables (such as collards, spinach, and turnip greens), orange vegetables (such as carrots, pumpkin, and sweet potato)</td>
</tr>
<tr>
<td>Birth defects</td>
<td>Dark-green leafy vegetables (such as spinach, mustard greens, and romaine lettuce).</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Baked potato or Sweet potato</td>
</tr>
</tbody>
</table>
Biotechnological approach to enhance nutritive value of vegetables

Genetic engineering enables vegetable breeders to incorporate desired transgenes into elite cultivars, thereby improving their value considerably. It further offers unique opportunities for improving nutritional quality and bringing other health benefits. Many vegetable crops have been genetically modified to improve traits such as higher nutritional status or better flavour, and to reduce bitterness or anti-nutritional factors. Transgenic vegetables can be also used for vaccine delivery. Consumers could benefit further from eating more nutritious transgenic vegetables, e.g. an increase of crop carotenoids by metabolic sink manipulation through genetic engineering appears feasible in some vegetables. Genetically engineered carrots containing increased Ca levels may boost Ca uptake, thereby reducing the incidence of Ca deficiencies such as osteoporosis. Fortified transgenic lettuce with zinc will overcome the defi-
ciency of this micronutrient that severely impairs organ function. Folates deficiency, which is regarded as a global health problem, can also be overcome with transgenic tomatoes with folate levels that provide a complete adult daily requirement. Biotechnology is a new, and potentially powerful, tool that has been added by most of the multinational private seed sector to their vegetable breeding programs. It can augment or accelerate conventional cultivar development programs through saving time, delivering better products, and ensuring genetic uniformity, or achieving some outputs that are not possible by conventional breeding. Conventional plant breeding that utilizes non-transgenic approaches will remain the backbone of vegetable genetic improvement strategies[14].

CONCLUSION

Vegetables have been a very important component of human diet, since time immemorial. But, their nutritional and therapeutic value have been studied and realized recently. The regular intake of prescribed quantity of vegetables by every individual for healthy life poses a challenge to the scientific community in the production of sufficient quantity of vegetables, especially in developing countries. Biotechnological approach is proving to be helpful in overcoming the challenge.

REFERENCES