ISSN : 0974 - 7532 Volume 9 Issue 11

Research & Reviews in

BioSciences

Review

RRBS, 9(11), 2014 [399-405]

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.

KEYWORDS

Vegetables;
Health;
Human diet;
Nutrient;
Therapeutic value;
Food safety.

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.

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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

Class	Vegetables	Nutrients
Green vegetables		
Leaf vegetables	Beet, cabbage, chicory, salad greens, spinach	DF, V, M
Stem vegetables	Asparagus, cardoon, celery	V, M
Fruit and flower Vegetables	Artichoke, eggplant, broccoli, cauliflower, zucchini, cucumber, mushroom, pepper, tomato, okra	DF, V, M
Root vegetables		
Root, bulb, and tuber vegetables	Beet, carrot, 'fennel, onion, potato, radish, turnip	DF, CC, V, M

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] TABLE 2. 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

	Minerals	Vitamins	Energy
Water (g) 79-96	Ca (mg) 10-170		
Protein (g) 0.5-5.0	P (mg) 12-125	β –carotene (mg) 0.1-5.0	(Kcal) 10-85
Fat (g) 0.1-1.0	Fe (mg) 0.2-8.0	C (mg) 3-230	(Kj) 42-356
Carbohydrate (g) 0.5-18.0	Na (mg) 2-150	B6 (mg) 0.1-0.2	
Dietary fiber (g) 0.8-8.0	K (mg) 200-600		

TABLE 3 : Therapeutic value of some vegetables

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.
Broccoli	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 rate model.
Cabbage	Rich in minerals, especially potassium and vitamins A, B6, and C. Antidiarrhetic, antiscorbutic, and antiseptic ethylamine, ferulic acid, fiber, fluorine, folacin, clucoiberin, glutamic acid, glycine, iron, isomenthol, 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.
Carrot	Rich in carotenoids, the main constituents are pyrrolidine, duacine, and daucosterine. Its essential oil has limonene, pinene, and cineole. 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
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, glucoerucin, glucoberin, glutamic acid, phydroxybenzoic acid, indole-3-carboxylic acid, linoleic acid, maleic acid, methanol, molybdenum, neoglucobrassicin, palmitic acid, pantothenic acid, phytosterols, quercetin, quinic acid, selenium, silicon, stigmasterol.
Radish	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, phytin, 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 ferulic acid, gentisic acid, raphanusin, erucic acid, glycerol, sinapate, raphanin, and Sulforaphen.
Eggplant	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, enterrhagia, and hematuria. 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 calmative, 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.
Lettuce	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, beta-lactucerol, lactucin, lactucopicri, lanthanum, alphalinolenic acid, lysine, molybdenum, oleic acid, oxalic acid, palmitic acid, palmitoleic acid, pantothenic acid, prolin, quercetin, selenium, sitosterol, stearic acid, stigmasterol, tryptophan, tyrosine. Contains saponin, saponaretin, and vitexin.
Okra	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. 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, leucorrhea, and nausea.

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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 alterative, 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, thiosulfinates, citrate, malate, polysaccharides A and B, quercetin, thymine, kaempferol, carotenes, and 0-coumaric, caffeic, ferulic, sinapic, p-coumaric. Onion has been used 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, cholesterin, betaine, trigonelline, choline, adenine, lysine, erepsin, leucine, arginine, tryptophan, phytin, vernin, asparagine, glutamine, alantoinase, urea, pepsin, trypsin, amylase, maltase, catalase, lipase, nuclease, phytagglutinin, abscisic acid, and gibberellin A. It is one of the better sources for choline, which may prevent liver cancer. The drug moxylohydroquinone reduced spermatozoa in males by ca. 50%, with the count reverting to normal in about four days. Experimental results suggest a hypoglycemic effect. Fresh green peas contain crude fiber, ash, calcium, phosphate, iron, potassium and beta-carotene equivalent, thiamine, riboflavin, niacin, and ascorbic acid.
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. The Chinese have used corn silk successfully to treat swelling caused by kidney disease, according to pharmacognosists.
Sweet potato	It contains cryptoxanthin, vitamin K3, α-tocopherolquinone, gibberellic acid, dihydro-B-sitosteryl ferulate, 7-dimethoxy-2-benzozolinone, 6-methoxy-benzozolinone, benzoxazin, and malate dehydrogenase. A tuberous-rooted perennial, usually grown as an annual. The top is herbaceous, with the stems forming a running vine, usually prostrate and slender with milky juice. 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. 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.
Tomato	In folk medicine, it is used as a remedy for mouth and throat tumors, asthma, burns, diarrhea, fever, nausea, and stomach disorder. It is alterative, aphrodisiac, astringent, bactericide, demulcent, laxative, and tonic. The tomato plant contains protein, fat, carbohydrate, minerals such as calcium, phosphorus, and iron, carotene, thiamine, nicotinic acid, riboflavin, and ascorbic acid. It also contains vitamins A and C, adenine, carotenoids, lycopene, tomatine, tomatidine, solanine, solanidine, and trigonelline. Carotenoids in tomatoes can reduce risks of breast cancer and prostate cancer and infection by certain viruses, can help in lowering blood pressure, and can be used to treat cloistral. Tomato is ranked among the top five vegetables in antioxidant activity assays.
Turnip	Turnip greens are considered valuable in the diet, primarily because of the content of minerals, calcium, and iron, and vitamins A, B, and C. In folk medicine, it is used for its antivinous, digestive, diuretic, emetic, laxative, refrigerant, and resolvent properties. Turnip is also used as a remedy for arthritis, colds, dysentery, hematochezia, mastitis, rheumatism, scurvy, skin ailments, sores, spasms, and warts. It is also used as a remedy for arthritis, chest colds, fever, and flu. Leaves contain protein, fat, carbohydrate, fiber, thiamine, and riboflavin. Roots contain ascorbic acid.

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-

missible limits recommended by various agencies. However intake of Mn and Zn is comparable to the suggestive value but value of Cd is really alarming[10].

FOOD SAFETY MEASURES OF 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 is as under.

Food safety hazards in vegetables

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] TABLE 4.

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

TABLE 4 : Some examples of deficiency disorders protected by different vegetables

Name of Disorder	Vegetables use to protect disorder
Artery hardening	**Sweet potato vine, Onion**
Asthma	Chinese artichoke, Chinese radish, Ducks tongue grass, Horseradish, Lettuce, Indian lettuce, Parsnip, Pepper, Sweet basil, Watercress
Blood pressure	Celery, Chayote, Tomato, Broccoli, Prickly pear cactus, Yellow rattan palm, Rhubarb, Tomato
Blood sugar	Carrot, Chinese wolfberry
Bronchitis	Chinese spinach, Lettuce, Indian lettuce, Nightblooming cereus, Parsnip
Cancer	Ailanthus, Garlic, Tomato, Sweet corn, Water chestnut, Corn, Job's tears, Asparagus, Asparagus lettuce, Bitter gourd, Black nightshade, Carrot, Chicory, Chinese mustard, Chinese yam, Endive, Garlic, Ginger, Horseradish, Kidney bean, Konjac, Lettuce, Indian lettuce, Luffa, Pepper, Rhubarb, Thousand-veined mustard, Cauliflower
Cholesterol	Common bracken, Alfalfa sprout, Rhubarb
Intestinal disorder	Ceylon spinach, Lily bulb, Onion, Green onion, Rhubarb
Cardiovascular-disease	Broccoli, cabbage, cantaloupe, guava, leafy greens, pepper, potato, tomato
Heart disease	Dark-green vegetables (such as collards, spinach, and turnip greens), orange vegetables (such as carrots, pumpkin, and sweet potato)
Birth defects	Dark-green leafy vegetables (such as spinach, mustard greens, and romaine lettuce).
Hypertension	Baked potato or Sweet potato

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TABLE 5 : Classification of Hazards for food safety

Physical hazards	Physical hazards are foreign material in product that can cause injury. The high moisture content and soft texture of fruit, vegetables and root crops make them susceptible to mechanical injury. Contamination can result from contact with the soil; manure; improperly composted manure; irrigation water; fecal material from wild and domestic animals; farm, packinghouse, and terminal market workers; contaminated equipment in fields, packing-house, and distribution system; wash, rinse, and flume water; ice; cooling equipment and transportation vehicles; cross - contamination from other foods; and improper storage, packaging, display, and preparation
Biological hazards	Biological hazards in fresh produce come from micro-organisms such as bacteria, fungi (yeasts and moulds), protozoan, viruses and helminthes (worms), which can also be termed microbes
Chemical hazards	Chemical hazards may include heavy metals, pesticides residues, contaminants; fungicides etc.
Viral hazards	Viruses are very small organisms that are unable to reproduce and multiply outside a living cell and that cannot therefore grow on or inside food as bacteria do. However, raw fruit and vegetables may become contaminated by viral particles with exposure to contaminated water, soil, dust or surfaces. The virus could then infect the consumer of the product if it is consumed raw.
Parasitic hazards	Parasites are organisms that derive nourishment and protection from other living organisms known as hosts. Parasites are of different types and range in size from tiny, single-celled organisms (protozoa) to larger multi-cellular worms (e.g. helminths). They may be transmitted from animals to humans, from humans to humans, or from humans to animals. Several parasites have emerged as significant causes of food and waterborne disease.
Bacterial hazards	Bacteria pose a common food safety risk due to their omnipresence in our environment. Pathogenic bacteria potentially contaminate vegetables in all stages of the production chain.

TABLE 6 : Vegetables Production in 2001 and 2010

Vegetable	2001		2010	
	Area(ha)	Production(tones)	Area(ha)	Production(tones)
Cabbage	258.1	5678.20	369.00	7949.00
Brinjal	502.4	8347.70	680.00	11896.00
Cauliflower	269.9	4890.50	369.00	6745.00
Okra	347.2	3324.70	498.00	5784.00
Onion	495.8	5252.10	1064.00	15118.00
Peas	303.3	2038.20	370.00	3517.00
Tomato	458.1	7462.30	865.00	16826.00
Potato	1259.5	24456.10	1863.00	42339.00
Sweet Potato	131.9	1130.70	113.00	1047.00

than 4% except decline in sweet potato. The results show that Indian vegetables production depicted glorious past and expected promising future. The area and production trends of Indian vegetables during 2001 and 2010 are presented in the TABLE-6[13].

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 out-puts 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.

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