

Health benefits of vegetable consumption in human nutrition: A review

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ABSTRACT: Vegetables are an important part of a healthy diet, providing a range of vitamins, minerals and other nutrients needed for growth, development, and to maintain good health. This review examines the importance of vegetables in human nutrition and emphasises their classification, nutritional composition, health benefits, factors affecting vegetable nutritional quality and strategies to increase vegetable consumption. According to a prior study, regular vegetable consumption is linked to preventing micronutrient shortages and lowering the risk of chronic illnesses like obesity, diabetes, cardiovascular disease, and some types of cancer. Despite the emphasis on the importance of vegetables, many nations worldwide do not consume the necessary amounts of vegetables. To increase vegetable availability and consumption, nutrition education, home gardening promotion, improved distribution and preservation systems, and supportive public health policies are required. This review confirms the need for vegetables in order to improve nutrition, public health, and ensure sustained food and nutrition security and also the need to increase regular vegetable consumption.

Keywords: Minerals, nutritional composition, vegetables, vitamins.

INTRODUCTION

A vegetable is an edible herbaceous plant, cooked or eaten raw as a main course, side dish or appetiser. Vegetables are an important part of a healthy diet, providing a range of vitamins, minerals and other nutrients needed to maintain good health. Available in different colours, shapes and flavours, each has unique nutritional benefits (Rathour *et al.*, 2024). Vegetables are considered the edible parts of plants (e.g. seed-bearing structures, flowers, buds, leaves, stems, shoots and roots), either cultivated or harvested wild, in their raw state or in a minimally processed form (FAO, 2021).

Vegetables play an important role in the human diet, not only because they are a source of nutrients essential for human health, but also as sources of protection. Vegetables are "significant sources of vitamins, minerals, dietary fibre and antioxidants that contribute to diversified, balanced and healthy diets" (FAO, 2021). Vegetables have been well-established to prevent diseases. According to the World Health Organisation (WHO), an increased intake

of vegetables can help lower the risk of non-communicable diseases (WHO, 2023). This emphasises the importance of sufficient vegetable consumption to help decrease the burden of chronic diseases, such as cardiovascular disease, obesity, diabetes and some forms of cancer. Vegetables are also a good source of bioactive compounds that benefit the body's physiological functions and well-being. Fruits and vegetables are regarded as one of the primary sources of bioactive compounds in the human diet, and their regular consumption is associated with improved health effects (Devirgiliis *et al.* 2024). Despite this, the issue of low vegetable intake is still a major nutrition issue at the global level. WHO (2023) suggests a minimum of 400 g of fruit and vegetables per day for good health and lower disease risk; however, many populations are not meeting this recommendation.

Apart from that, vegetables are also essential for digestive health because of their fibre content, as well as preventing nutrient deficiencies. Fruits and vegetables are

associated with a lower risk of many chronic diseases, as well as being a source of nutrients which are essential for health and maintenance of the body (Slavin and Lloyd, 2012). Vegetable intake in the diet needs to be promoted to improve human nutrition and thereby increase the quality of life. Hence, this review focuses on the nutritional significance, with an emphasis on the key health benefits of vegetables in human nutrition.

CLASSIFICATION OF VEGETABLES

There are five methods by which vegetables can be classified into:

According to the part consumed (disposition)

Leafy vegetables: For consumption, succulent young shoots and leaves are chosen. e.g., Amaranthus, Celosia, Pumpkin, Lettuce, Cabbage, Bitter leaf, Water leaf, Jews mallow and Fluted pumpkin are some of them (Olasantan *et al.*, 2012).

Fruit vegetables: These are either mature and ripe fruit from plants grown as vegetables or young and immature, unripe fruits. Examples are Cucumber, Tomato, Okra, Pumpkin, Eggplant, Garden egg, Water melon, Sweet pepper and Chilli pepper (Olasantan *et al.*, 2012).

Seed vegetables – The seed is the economic part. Egusi and Ito melons are two examples (Olasantan *et al.*, 2012).

Root vegetables: Tubers and/or roots are consumed, e.g., carrots, radish, sweet potato, Irish potato (Olasantan *et al.*, 2012). **Spices:** These are used for culinary purposes because of their colour and taste, such as Basil, Onion, Garlic and Chillies (Olasantan *et al.*, 2012)

Spices: Significant for their colour, flavour, and taste in food, such as chilli pepper, onion, garlic, and Basil (Olasantan *et al.*, 2012).

According to the season or area of production

Cool season vegetables: Examples include: Cabbage, garlic, onion, radish, spinach, lettuce, potato and carrot (Olasantan *et al.*, 2012).

Warm season vegetables: These include: Tomato, Pepper, Cucumber, Okra, Eggplant, Garden egg, Melon, Pumpkin, Sweet potato (Olasantan *et al.*, 2012).

According to their botany or taxonomy

As shown in Table 1, vegetables can be classified according to their botany or taxonomy.

According to their frequency of cultivation

Regularly cultivated vegetables: Regularly cultivated vegetables are those which are grown and tended on a regular basis by farmers for food, income and commercial purposes. They are widely grown due to their great demand and have a substantial economic and nutritional worth. Examples Include: Cucumber (*Cucumis sativus*), Amaranthus (*Amaranthus spp.*), Okra (*Abelmoschus esculentus*), Tomato (*Solanum lycopersicum*), Eggplant (*Solanum melongena*), Pepper (*Capsicum spp.*) and Celosia (*Celosia argentea*). (Olasantan *et al.*, 2012).

Occasionally/wild vegetables: Occasional vegetables (also wild vegetables) are those plants that grow in the wild. In rural areas they play an important role in the diet and are usually collected from their natural habitat. These include Bologi (*Cresocephalum biafrae*), Ebolo (*Cresocephalum crepidioides*), Red vine spinach (*Basella rubra*), White vine spinach (*Basella alba*) and Mushrooms (*Agaricus spp.*) (Olasantan *et al.*, 2012).

According to their maturity time, harvesting pattern and growth habit

Vegetables like Celosia, Amaranthus, Capsicum spp., Tomato, Okra, and Cucurbits are examples of vegetables that can be harvested over a period of weeks or months (Olasantan *et al.*, 2012).

Vegetables with climbing growth habit: These vegetables are trained along stakes and on the walls of homes. Snake gourd, fluted pumpkin, Ito melon, and *Basella* species are a few examples. Melon, cucumber, and watermelon are examples of vegetables with creeping stems. (Olasantan *et al.*, 2012).

According to their nutritional composition of vegetables

In terms of nutrition, vegetables can be grouped as macro and micronutrients. Macronutrients consist of water, carbohydrates, proteins, lipids and fibre. Micronutrients consist of two wider groups, namely, vitamins and minerals (Table 2). Vitamins can also be further divided into water-soluble and fat-soluble (Butt and Sultan, 2018).

HEALTH BENEFITS OF VEGETABLE CONSUMPTION

Prevention of chronic diseases

A diet high in fruits and vegetables has been demonstrated to significantly reduce the risk of stroke and heart disease. A meta-analysis of cohort studies of 469,551 participants has shown that higher intake of fruits and vegetables is

Table 1. According to their botany or taxonomy.

Family	Botanical name	English name
Amaranthaceae	<i>Amaranthus dubius</i>	Amaranth
	<i>Celosia argentea</i>	Celosia
Apiaceae	<i>Daucus carota</i> ,	Carrots
	<i>Apium graveolens</i> ,	Celery
	<i>Petroselinum crispum</i> ,	Parsley
	<i>Foeniculum vulgare</i> .	Fennel
Brassicaceae	<i>Brassica oleracea</i> ,	Cabbage
	<i>Brassica oleracea var. botrytis</i> ,	Cauliflower
	<i>Brassica oleracea var. italica</i> ,	Broccoli
Cucurbitaceae	<i>Cucurbita maxima</i>	Pumpkin
	<i>Cucumis sativus</i>	Cucumber
Malvaceae	<i>Abelmoschus esculentus</i> L.	Okra
	<i>Corchorus olitorius</i> L.	Jews mallow
Solanaceae	<i>Solanum tuberosum</i>	Irish potato
	<i>Solanum melongena</i> L.	Eggplant
Cucurbitaceae	<i>Cucumis sativus</i>	Cucumbers
	<i>Cucurbita pepo</i>	Pumpkins
	<i>Cucumis melo</i>	Muskmelon
Compositae	<i>Vernonia colorata</i>	Bitter leaf
	<i>Lactuca sativa</i>	Lettuce
Cruciferae	<i>Brassica oleraceae</i>	Cabbage
	<i>Raphanus sativus</i>	Radish
Portulacaceae	<i>Talinum triangulare</i>	Water leaf
Basellaceae	<i>Basella rubra</i>	Indian spinach
Alliaceae	<i>Allium cepa</i>	Onion
	<i>Allium cepa var. aggregatum</i>	Multiplier onion
	<i>Allium porrum</i>	Leek
	<i>Allium sativum</i>	Garlic
	<i>Allium fistulosum</i>	Welsh onion
	<i>Allium cepa var. aggregatum</i>	Shallot
	<i>Allium schoenoprasum</i>	Chive
Liliaceae	<i>Asparagus officinalis</i>	Asparagus
Poaceae	<i>Zea mays var. rugosa</i>	Sweet corn
Solanaceae	<i>Solanum lycopersicum</i> ,	Tomatoes
	<i>Solanum melongena</i> ,	Eggplants
	<i>Capsicum</i> species.	Peppers

Source: Patel *et al.*, 2025; Dhaliwal, 2017; Olasantan *et al.*, 2012.

associated with a reduced risk of death from all causes, particularly cardiovascular death (Wang *et al.*, 2014).

A study also took place at the Harvard-based Nurses' Health Study and Health Professionals Follow-up, the largest and longest study to date, involved nearly 110,000 men and women who were followed for 14 years, and their food and health habits also showed that the probability of developing cardiovascular disease declines with increasing average daily consumption of fruits and vegetables (Harvard, 2026; Hung *et al.*, 2004).

Prevent diabetes

Eating fruit and green leafy vegetables was associated with a lower risk of diabetes, according to a study of almost 70,000 female nurses between the ages of 38 and 63 who were free of diabetes, cancer, and cardiovascular disease (Harvard, 2026; Bazzano *et al.*, 2008). Additionally, a study including over 2,300 Finnish men found that consuming fruits and vegetables, especially berries, may reduce the prevalence of type 2 diabetes (Mursu *et al.*, 2014).

Table 2. Some selected vegetables and their nutritional composition.

S/N	Cultivars type	Description	Nutritional value
1.	Amaranthaceae Amaranthus	An edible green leaf of the amaranth family.	Amaranthus contains protein (13-15%), carbohydrate (60-65%), calcium, iron, magnesium, phosphorus, potassium, Vit. C, Vit. A (beta-carotene), and folate.
	<i>Celosia argentea var. argenta</i> (Lagos spinach, quail grass, soko, celosia or feather cockscomb)	A broadleaf annual of the Amaranth family.	This is a great source of vitamins A and C, also good in protein, iron, and calcium.
	<i>Spinacia oleracea</i> (Spinach)	An annual leafy vegetable. The leaves are simple, oval to triangular, alternate with broad leaves on the lower part of the stem, thinning at the apex.	Rich source of vitamin A, vitamin C, vitamin K, Mg, Mn, folate. Also, a good source of B vitamins, vitamin E, potassium, calcium and dietary fibre.
2.	Amaryllidaceae <i>Allium cepa</i> (Onion, spring, scallion, shallot)	These are fleshy, hollow, cylindrical biennial bulbs.	Contains carbohydrate, fibre, and some amount of vitamins like thiamine, vitamin C, B6, niacin, riboflavin, and minerals like Ca, Fe, Zn, K, Mn.
	<i>Allium sativum</i> (garlic)	A perennial flowering bulb.	Carbohydrate, fibre, protein, manganese, vitamin B6, vitamin C, selenium, and calcium.
3.	Apiaceae Carrot (<i>Daucus carota</i>)	Sweet tasting, crunchy root vegetables of the Apiaceae family.	Carrots are rich in beta-carotene (which your body converts into vitamin A), Lycopene, Alpha-carotene, Fiber, Potassium, Vit. B, K1, B6.
	<i>Apium graveolens</i> (Celery)	A biennial plant with pinnate leaves. Consumption assists in weight loss.	Has about 95% water, a very good source of vitamin K with Zn, Na, K, P, Mg, Fe, and Cu.
4.	Asteraceae Lettuce (<i>Lactuca sativa</i>)	A hardy, fast-growing annual vegetable typically grown for its leaves, characterised by high water content, mild flavor, and crisp texture.	It contains water, fibre, carbohydrate, protein, Ca, Chl, Cu, Fe, Mn, Vit. B1, B2, B3, B5, B6, B9, Vit. C, Vit. E, Vit. K1.
	<i>Vernonia amygdalina</i> (Bitter leaf)	A shrub and member of the daisy family with elliptical leaves and rough bark. Grows up to 20 cm long.	High protein content, crude fibre. Also contains minerals like NA, Fe, Mg, Zn, Ca, and K.
5.	Brassicaceae <i>Brassica oleracea var. capitata</i> (Cabbage)	This is a leafy green, red-purple, or pale green vegetable crop.	This has about 96% water, low carbohydrate, fibre, negligible fat, and protein. Rich in vitamins K1, C, and B6, folate, and manganese.
	<i>Brassica oleracea var. italica</i> (Broccoli)	From the cabbage family. The flowering head, leaves, and stalk serve as a vegetable. Particularly helpful in preventing cancer.	Contains lots of calories. A rich source of vitamins C and K. Also contains carbohydrate, fibre, sugar, fat, protein, folate, and manganese.
6.	Cucurbitaceae <i>Cucumis sativus</i> (Cucumber)	A creeping vine that bears cylindrical fruits used as vegetables.	Contains 95% of water with carbohydrates and proteins, also minerals such as Ca, Fe, Mg, Mn, K, P, Na, and Zn, with loads of vitamins.
	<i>Cucurbita pepo</i> (Pumpkin, squash, marrow, zucchini)	The plump nutritious orange vegetable.	Rich in vitamin C, potassium, and fibre. Super rich in provitamin A, beta-carotene and vitamin A.
7.	Euphorbiaceae <i>Manihot esculenta</i> (Cassava leaves)	A vegetable with a long tapering root.	Contains vitamins B6 and C, Fe, Ca, Mg. The leaves are rich in leucine. While the root is high in dietary fibre, carbohydrate and sugar.
8.	Malvaceae <i>Abelmoschus esculentus</i> (Okra)	A warm-season vegetable known for its mucilaginous (slimy) texture, high-fibre content, and culinary versatility.	Contains carbohydrates, minerals and vitamins. K, Na, Mg and Ca were found to be the principal elements, with Fe, Zn, Mn and Ni also present.
	<i>Corchorus olitorius</i> (Jew's mallow, bush okra, nalta jute, jute plant)	The jute plant is used as fibre, while the leaves and young fruits serve as a vegetable.	A rich source of vitamin A and C, fibre, zinc, and thiamine.
9.	Poaceae <i>Zea mays</i> convar. <i>Saccharata</i> (Sweetcorn)	It's the seed of a plant in the grass family.	Contains Carbohydrate, Protein, Fibre, Vitamins, Mn, K, Mg, Vit B, Vit. B5, B9 and B3.
10.	Solanaceae <i>Solanum lycopersicum</i> (Tomatoes)	Edible vines with berries.	A major source of antioxidants is lycopene. Also contains 95% water, protein, carbohydrate, fiber, K vitamins B and E.
	<i>Capsicum annuum</i> (Pepper, Bell pepper, Sweet pepper)	This belongs to the nightingale family and is cultivated for the thick fruit.	Rich in vitamins C, carbohydrates, fibre, sugar, fat, protein, vitamin B6, folate, potassium, and manganese.
11	<i>Solanum melongena</i> (Eggplant)	Belongs to the nightshade family and is cultivated for its purple, spongy, absorbent fruits.	Fibre, fat, protein, Mg, K, Cu, folate, vitamin C and vitamin B6.

Source: Bjarnadottir, 2026; Ebabhi and Adebayo, 2021; ZATRA, 2019; Sindhu and Puri, 2016; Moyin-Jesu, 2007.

Improves digestive health

Leafy greens like spinach and kale are rich in fibre and minerals like folate, vitamin C, vitamin K, and vitamin A. Research indicates that a specific type of sugar found in leafy greens also encourages the development of healthy gut flora (John Hopkins Medicine, 2026). Fruits and vegetables include indigestible fibre, which swells as it passes through the digestive system after absorbing water. Encouraging regular bowel movements, this can treat or prevent constipation and lessen the symptoms of an inflamed stomach (Harvard, 2026; Lembo and Camilleri, 2003).

Weight Management

A study that was published in PLoS Medicine claims that eating more fruits and vegetables aids in weight control (Bertoia *et al.*, 2015). One useful tool for controlling weight is vegetables. In addition to providing fibre, vitamins, minerals, and phytochemicals, they have a high volume and relatively low energy density. According to Karla Wichary (2026), this combination can help structure regular eating habits and promote fullness.

Boost Immune System

However, in one randomised controlled trial, researchers looked at how immunological outcomes in older persons were affected by high (≥ 5 servings per day) and low (≤ 2 servings per day) fruit and vegetable diets. The group that ate more fruits and vegetables had a higher antibody response to the pneumococcal vaccine after a 12-week dietary intervention. This suggests that a diet rich in fruits and vegetables strengthens the immune system, maybe because these foods might supply the body with minerals and bioactives (Calder, 2022; Gibson *et al.*, 2012).

Mental health benefits

Increased consumption of fruits and vegetables has been linked to improved mental health outcomes, including reduced feelings of depression and increased well-being. Despite differences in study design, a thorough analysis of 61 observational studies found that the consistent findings support recommendations of consuming at least five servings of fruits and vegetables daily for mental health benefits (Głabska *et al.*, 2020).

Four hundred and twenty-two (422) young adults (66.1% female) between the ages of 18 and 25 who resided in the United States and New Zealand completed an online survey in a cross-sectional design that assessed their typical consumption of raw versus cooked, canned, or processed fruits and vegetables, as well as their positive and negative mental health and covariates. The study's findings showed that consuming raw fruits and vegetables

was a better indicator of mental health than consuming processed fruits and vegetables (Brookie *et al.*, 2018).

FACTORS AFFECTING VEGETABLE NUTRITIONAL QUALITY

Genetic composition

There is a wide variety of genotypic variation in composition, quality, and post-harvest life potential within each commodity grouping. Plant breeders have successfully worked on retaining the nutritional content of some vegetables. (Kader, 2004).

Climatic factors

The nutritional value of fruits and vegetables is significantly impacted by climate variables, especially temperature and light intensity. Ascorbic acid, carotene, riboflavin, thiamine, and flavonoid contents can therefore be determined by the manufacturing site and the growing season. The amount of ascorbic acid in plant tissues generally decreases with decreasing light intensity. Because transpiration rates rise with temperature, temperature affects how plants absorb and use mineral nutrients. Rainfall has an impact on the plant's water supply, which may have an impact on the harvested plant part's composition and its vulnerability to decay and mechanical damage during further harvesting and handling procedures (Kader, 2004).

Cultural practice

The nutrient production of agricultural systems can be impacted by the cultural practices employed by farmers (Welch, 2001). The composition of food is greatly influenced by agricultural practices, which also have a direct impact on nutritional quality and the capacity to solve food and health issues (Anim *et al.*, 2025).

Harvest, postharvest handling and storage

The most significant factor influencing storage life and the quality of the final product is maturity at harvest. Immature products are more vulnerable to Mechanical deterioration, and shrivelling is of lower quality. As a result, fruits and vegetables are harvested at the appropriate maturity stage. Furthermore, the quality of the vegetables depends on when they are harvested; harvest timing can affect texture, colour, size, flavour, and tenderness. Moreso, the composition and post-harvest quality of fruits can be greatly impacted by the harvesting techniques (Manual versus Mechanical). Brushing, surface abrasions, and cuts are examples of mechanical injuries that can hasten the loss of water and vitamin C, making the body more vulnerable to bacteria that cause decay. Leafy vegetables

are picked by hand. Mechanical harvesting is used for root crops, including carrots, onions, potatoes, and sweet potatoes, as well as some commodities meant for processing, like tomatoes, etc. (Ramjan and Ansari, 2018)

Almost all fruits and vegetables need to be prepared in a certain way. Root and tuber crops are among the vegetables that are frequently cleaned to eliminate the soils sticking to them. In addition to being clean, washing with water enhances the appearance of vegetables and keeps them from withering. Before many veggies are ready for the market, they must be clipped. Fresh fruit and vegetable packaging is crucial for cutting down on waste (Ramjan and Ansari, 2018).

Temperature control is crucial for storage. Fresh vegetables should be stored at the lowest possible temperature to prevent chilling damage; any deviation from this ideal state is harmful. The relative humidity of the storage rooms also has a significant impact on the horticultural produce's ability to be stored (Ramjan and Ansari, 2018).

STRATEGIES TO INCREASE VEGETABLE CONSUMPTION

Nutrition education

Educating people about the importance of eating more vegetables is crucial. One of the key strategies for boosting vegetable consumption is educating individuals about better eating practices, attitudes, and behaviours. It entails teaching individuals and communities about the nutritional value of vegetables, how much of them should be consumed daily, and practical strategies for doing so. The World Health Organisation claims that "A minimum of 400 grams of fruits and vegetables should be consumed daily by anyone over the age of ten (WHO, 2026).

Home gardening/market gardening

Home gardening, which makes fresh vegetables more accessible, affordable, and available to households, is one strategy to boost vegetable intake. Small areas of land, backyards, and residential complexes are used to raise vegetables. This facilitates easy access to nutrient-dense, fresh vegetables. One way that home gardening supports household food security is by providing direct access to food that may be gathered, cooked, and served to family members, often daily (FAO, 2001; 1997)

Food security can be improved, and market purchases can be efficiently supplemented with homegrown items, particularly fruits and vegetables. It is crucial to raise awareness of the established advantages of diversified gardening, especially its capacity to improve the diversity of family food items by boosting intakes of fruits, vegetables, and staple foods (Adeosun *et al.*, 2025). Market gardens are commercial enterprises that maintain careful production, typically using organic materials.

Government/public health programs

By promoting access, affordability, awareness, and a healthy food environment through policies and community interventions, a variety of public health and government initiatives will contribute to a rise in vegetable consumption. Fruit and vegetable voucher incentive programs and produce prescription programs are tried-and-true strategies to raise the price and availability of healthful foods. Programs like these increase the consumption of fruits and vegetables (CDC, 2024).

Improved preservation and distribution.

Improved distribution and preservation lead to higher vegetable consumption by reducing postharvest losses, extending shelf life, increasing year-round availability, and making veggies more accessible and reasonably priced for consumers. Reducing postharvest losses would increase the amount of fresh produce accessible for consumption (Onwude *et al.*, 2020).

CONCLUSION

Overall, the review underscores the importance of vegetables as a vital source of nutrients and health benefits for human nutrition and health. It covered the classification of vegetables, their nutritional composition, health benefits, factors affecting their nutritional quality, and how to increase vegetable consumption. The results show that regular vegetable consumption plays an important role in the prevention of diseases, nutritional status and quality of life. Despite the proven benefits of vegetables, however, vegetable consumption in many populations around the world is lower than the recommended levels. Hence, a greater emphasis on nutrition education, increased access to fresh and affordable vegetables and greater implementation of supportive public health policies and interventions to increase vegetable intake for improved health outcomes are required.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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