

Nutritional Quality of Colored Vegetables: A review

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Abstract

Vegetables are a crucial part of the human diet and a major source of biologically active substances, vitamins, minerals, and phytochemicals. Coloured vegetables are rich in all these and are great sources of antioxidants. An easy way to get a complete range of vitamins and minerals is by eating a diversity of colourful foods which our body needs to thrive. Mainly these five types (Red, Orange/Yellow, White/Brown, Green, Blue/Purple) of vegetables cover almost all the vegetables which consume in our diet daily basis. For people suffering from atherosclerosis, hypertension, and high cholesterol, red vegetables are the best option to get higher antioxidants, Lycopene, and ellagic acid fight against cancer. Vitamin C boosts overall immunity. Carotenoids in yellow colour vegetables are good for healthy eyesight. Blue vegetables provide flavonoids. White/brown veggies, like green vegetables, are high in phytonutrients. Folate in green vegetables helps to prevent congenital disabilities in pregnant women. Different diseases can be avoided by eating a variety of coloured vegetables in the right proportions. Consuming coloured vegetables is not only vital but also necessary to reap all of the health advantages. This article makes a review and discussion on the nutritional quality of major types of colourful vegetables.

Keywords: Antioxidant; Coloured vegetables; Health benefits; Nutritional quality; Vitamins

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Introduction

Vegetables are annual and perennial horticulture crops. It is very important to have a successful, healthy diet. These are the rich sources of phytonutrients: vitamins (A, B1, B6, B9, C, E, and K), minerals, dietary fiber, and phytochemicals (flavonoid, phenolic compound, bioactive peptide, etc.) [1]. Bioactivity of vegetables' phytochemicals toward human biochemistry and metabolism has been widely tested for their ability to provide a health benefit. Phenolic, terpenoids, glucosinolates, polyacetylene, phytosterols, and phytostanols are the major classes of phytochemicals. Vegetable antioxidants may help to prevent or lower the risk of chronic diseases such as diabetes, cardiovascular disease, obesity, cancer, inflammation, stroke, and septic shock. A good vegetable diet reduces the risk of cardiovascular disease in humans [2]. According to the Global Status Report on Non-communicable Diseases (2010), WHO, approximately 16 million

(2.0%) DALYs and 1.7 million (2.8%) deaths worldwide are due to low consumption of fruits and vegetables. ICMR recommended the daily consumption of 300 gm of vegetables in the diet to help build a healthy body.

Different types of coloured vegetables

The worldwide vegetable survey showed 402 vegetables are cultivated, which represent 69 families and 230 genera. The main difference is that each vegetable group contains a different amount and combination of phytonutrients, which distinguishes them from other groups and vegetables within their group [15]. The vegetables can be divided into five main colour groups, viz: red, orange/yellow, white/brown, blue/purple, and green. Due to the colour of the vegetables, some specific phytonutrients and antioxidants are present that are unique to each coloured vegetable group. Red-coloured vegetables are a rich source of lycopene and anthocyanin. Orange and yellow-coloured

vegetables are a good source of beta carotene and zeaxanthin. Carrots in this group also contain a unique combination of three flavonoids: luteolin, kaempferol, and quercetin. Dark green leafy vegetables are rich in vitamin A, C, E, and K, also a good source of lutein and folate. Quercetin is the highest amount found in onion leaves. Some vegetables also have the goodness of more than one colour, e.g., cucumbers with their green skin and white flesh. Colourful foods, which are generally fruits and vegetables, contain vitamins and antioxidants with few calories. Along with maintaining good health, the nutrients in vegetables and fruits work together to protect against hypertension, vision loss, heart disease, cancer, and other diseases. Awareness among the people in this rapidly increasing world population about the importance of vegetables for a healthy diet led to making tomorrow better.

Red colour vegetables: Red vegetables protect our hearts. Most of these vegetables contain antioxidants that reduce the risk of developing atherosclerosis, hypertension, and high cholesterol. They are enriched in vitamins and nutrients. They also improve brain function and reduce the risk of acquiring many cancers, including prostate cancer. Tomatoes, reddish capsicums, red potatoes, red cabbage, and beets are examples of red vegetables.

Lycopene and anthocyanin are abundant in red-coloured foods. Lycopene is an antioxidant that lowers the risk of a variety of diseases, including prostate cancer [16]. Anthocyanins are thought to protect the liver, lower blood pressure, and reduce inflammation, as well as improve vision. Tomatoes are high in lycopene, beta carotene (an antioxidant that our bodies convert to vitamin A), naringenin, chlorogenic acid (which may decrease blood pressure), vitamin C, and potassium [17]. Fresh tomatoes provide about 85% of the lycopene in our diet. Beetroot is also high in fibre, vitamin B9, magnesium, iron, vitamin C, and folate. Inorganic nitrate in beetroot reduces blood pressure. A single cup of red cabbage can provide 85% vitamin C, 42% vitamin K and 20% vitamin A. Red chili paper contains the cancer-fighting chemical capsaicin. Red onions contain a higher amount of organosulfur, phytochemicals improve the immune system, reduce cholesterol production. Reddish detoxifiers' crunchiness protects the intestines, kidneys, and stomach. Red potato is also a good source of phytonutrients that have antioxidant properties like carotenoids, flavonoids, caffeic acid, etc.

Orange/yellow colour vegetables: Antioxidants abound in yellow and orange vegetables, notably carotenoids, which give them their yellow-orange colour. These contain a greater amount of phytonutrients including vitamin C, flavonoids also a good source of fiber. Other nutrients, such as folate, potassium, and calcium, are present in various levels. Yellow vegetables include yellow carrots, Pumpkin, Butternut squash, corn, orange bell pepper, yellow bell paper, yellow tomatoes, orange tomatoes, yellow cauliflower, yellow beans, yellow onions, yellow potato, Rutabagas, yellow/golden beets, etc.

Carrot is a crunchy, tasty, and highly nutritious vegetable. It's high in beta carotene, vitamin A, potassium, antioxidants, and carbs (10%). Carrots help to lower cholesterol, lose weight, and enhance overall health. Pumpkin, nutrient enrich like a carrot. It

is high in vitamins A, C, and E. The immune system is boosted by iron and folate. Lutein and Zeaxanthin protect eyesight. Orange pigment in cauliflower concerted in vitamin A supports healthy organ functioning, improves skin complexion, and strengthens the immune system. Golden beet contains the antioxidant betaxanthin. Golden beet contains a good amount of carb, fat, protein, K, and other minerals.

White/brown colour vegetables: Phytonutrients are abundant in white and brown vegetables. These vegetables are rich in P, beta-glucans, lignin, flavones, and flavanols (anthoxanthins). Cauliflower, garlic, ginger, onion, mushroom, turnips, and parsnips are examples of this type of vegetable. These nutrients are good for heart health, boosting the immune system, digestive tract health, and metabolism.

Cauliflower contains almost every vitamin but is low in calories. Though it contains a high amount of fiber that is good for digestive health and chronic diseases. Cauliflower has antioxidants that help to alleviate inflammation. Garlic contains sulfur compounds which having health benefits. Antioxidant selenium found in garlic protects against heart diseases. Garlic's antioxidants protect cells from damage and ageing, as well as lowering the risk of Alzheimer's disease and dementia. Mushrooms include a variety of bioactive substances that may help to prevent cancer, heart disease, and enhance blood sugar control and intestinal health. Mushrooms have a higher protein content than animal protein sources. Turnip contains a high amount of dietary fiber which reduce the risk of intestinal problem, reduce blood pressure, cancer risk.

Blue/Purple colour vegetables: Blue/purple vegetables have a wide array of health benefits. These vegetables are high in anthocyanins, which have been shown to improve brain function, reduce inflammation, and fight diseases like cancer. It contains lutein, resveratrol, zeaxanthin, vitamin C, fibre, flavonoids, ellagic acid, and quercetin, among other nutrients. Purple cauliflower, purple asparagus, purple potatoes, eggplant, purple carrot, purple maize, purple kohlrabi, and other purple veggies are included.

Eggplant is high in fibre, vitamins, and minerals while being low in calories. It also has modest amounts of other nutrients like niacin, magnesium, and copper. Eggplant is high in fibre, vitamins, and minerals while being low in calories. It also has modest amounts of other nutrients like niacin, magnesium, and copper. Purple cauliflower is rich in nutrition. Vitamin C, vitamin A, fibre, folate, calcium, potassium, and selenium are all abundant in this vegetable. Purple carrots are loaded with nutrients like fiber and potassium. It contains a higher amount of antioxidants which are very beneficial for the health system that protects against heart disease, mental decline, and diabetes.

Green color vegetables: Leafy vegetables mostly come under this division. Many phytonutrients, minerals, vitamin C, B-group vitamins, folate, and fibre are abundant in them. There are different phytonutrients in different types of green vegetables, but they are all beneficial. Leeks, beans, peas, broccoli, green

capsicums, cucumbers, celery, cabbage, Brussels sprouts, asparagus, leafy greens, Asian greens, and salad leaves are examples of green vegetables.

Spinach is an important leafy green vegetable that can be used in several ways. It's high in folate, which can help prevent neural tube disorders like spina bifida during pregnancy. Spinach provides a greater amount of vitamin K, A, and Mg. Cabbage has cancer-protective properties due to the presence of Indol-3-carbinol. Raw cabbage turned into sauerkraut, which also has additional health benefits. Beet green is rich in calcium, potassium, riboflavin, fiber, and vitamins A and K. They also include the antioxidants beta-carotene and lutein, which help to prevent vision problems including macular degeneration and cataracts. pak choy contains the mineral selenium which is important for proper thyroid gland function.

Literature Review

Scientists have done a number of experiments in order to improve the nutritional quality of vegetables. Abbott JA experimented on the quality measure of vegetables and fruit at Horticultural Crops Quality Laboratory, USDA investigated quality measure encompasses nutrient values, chemical constituents, functional properties, etc. [3]. An optical approach of detecting carbs, proteins, and lipids, particularly in the near-infrared range, that may enhance quality indicators. Zhou, et al., investigated the application of the "Or" gene to improve the nutritional quality of cauliflower [4]. Carotenoids are a dietary supply of vitamin A, which is necessary for human health. But it is difficult to reach the desired amount of carotenoid to overcome this we needed carotenoid biosynthesis. They isolated *OR* gene from a high Beta carotene orange cauliflower mutant. *OR* is a plant-specific gene that encodes a plastid-targeted protein with a cysteine-rich zinc finger domain. Examination of the *OR* transgenic potato tubers confirms that the *OR*-induced carotenoid accumulation is associated with the formation of a metabolic sink. As a result, the *OR* gene provides a new genetic tool to supplement current nutritional enhancement strategies in agriculturally significant crops. Olaniyi, et al., evaluated the growth, fruit output, and quality of seven tomato cultivars on sandy loam soil at Ladok Akintola University of Technology's Teaching and Research farm from April to July 2004 [5]. They conclude that there is variance in the nutritional contents of tomato fruits among seven varieties of tomato, with local varieties (Ogbomoso and Ibadan Local) closely followed by UC82B recording the majority of nutritional values compared to the other types. Paradicovic, et. al., experimented on the impact of bio-stimulants on the yield and nutritional quality of sweet yellow pepper (*Capsicum annuum* L). The pigment content of leaves enhanced after treatment with natural bio-stimulants, as did vitamin C and antioxidant activity, compared to untreated plants. For obtaining high nutritional vegetable use of bio-stimulants is efficient and eco-friendly [6].

Kakon, et. al., carried an experiment on the mushroom as an ideal food supplement. Mushroom is a versatile, nutrient-dense food. It contains a higher amount of protein [7]. Mushroom is a

plant diet with low carbohydrate, zero fat, and enough vitamin and mineral content when compared to animal nutrition. It is a good source of high-quality fiber and low-caloric food. As a result, the mushroom makes an excellent food supplement. The yield, chemical composition, and nutritional quality responses of radish carrot and turnip to high atmospheric carbon dioxide were studied by Azam, et al. [8]. The yield of carrot, radish, and turnip increased by 69%, 72%, and 139% respectively, when grown under elevated CO₂ conditions. Among the proximate composition, protein, fat, vitamin C contents decreased significantly for all the vegetables while sugar and fiber contents were increased. In response to the vegetables to elevated CO₂, there was a significant decrease in many important minerals. The amount of fatty acids and amino acids in these vegetables was reduced by CO₂. They concluded that increased CO₂ boosted root vegetable yields, but it decreased numerous vital nutritional indices such as protein, minerals, vitamin C essential fatty acids, and amino acids. Xu, et al. investigated the nutritional quality of red cabbage cooked using various ways such as boiling, micro heating, steaming, and stir-frying. After cooking, they discovered a decrease in anthocyanin and glucosinolate concentration [9]. After steaming, there is a higher level of vitamin C retention and DPPH radical-scavenging action. There were also significant losses of vitamin C, phenolic, DPPA radical-scavenging, and reduction in soluble sugar after stir-frying and boiling. They determined that because red cabbage loses a lot of nutrients when cooked, it's best to eat it raw as a salad crop. Otherwise, it's best to cook it with less water and time. Grauwet, et al., used high pressure, high temperature, and thermal processing to test the nutritional, structural, and volatile components of yellow and orange carrots [10]. They found out that after High Pressure and High Temperature (HPHT) the amount of carotenoid level decreased from yellow carrot to orange carrot. Yellow and orange carrot nutritional quality had a similar effect on HPHT and thermal processing. At a food testing facility in JAU, (Gujrat) India, Kandoliya, et al., investigated the antioxidant and nutritional components of local eggplant varieties. Brinjal is high in antioxidants as well as phytonutrients. Their findings suggest that the pulp of local brinjal fruits contains radical scavenging activity of 25.17%-40.35%, flavonoids, anthocyanin, total phenol, protein, and titrable acidity, ascorbic acid, as well as total phenol, protein, and titrable acidity [11]. In a fresh brinjal pulp, the activity of polyphenol oxidase (PPO), the enzyme responsible for the browning response, ranged from 0.66 OD/min × g to 1.39 OD/min × g. These results indicate that variety is nutritionally found better due to its higher antioxidant property. Saranya, et al., experimented with different green leafy vegetables to find the best blanching temperature, time, and chemical medium. Different blanching temperatures result in considerable reductions in fiber, iron, and moisture content [12]. The study revealed the antioxidant properties and the presence of flavonoids, phenolics, and tannins in various proportions.

Comert, et al., conducted research into the relationship between fruit and vegetable colour and antioxidant capacity [13]. Their findings suggest that the colour of fruit and vegetable TAC can be linked to computer vision-based picture processing. Antioxidant

capacity (>10 mols TE/kg fresh weight) of those vegetables comes under having hue value above 180.0 and below 20.0. Anthocyanin-rich magenta and blue and red colour fruits and vegetables are in the high antioxidant. Carrillo, et. al., experimented on the amount of bioactive compound and nutritional properties in organic versus conventional beetroot cultivation. Their finding shows a difference in the amount of bioactive compounds and nutrition in conventional and organic cultivation [14]. This distinction is also dependent on the cultivar. Organic and convent both have similar levels of the flavonoids kaempferol-3-O-glucoside and luteolin.

Conclusion

Vegetables contain almost all nutrient compounds essential for human nutrition as well as a large number of health-promoting chemical substances. Coloured vegetables play a crucial role in human nutrition. Since the vegetable intake continues to be lesser than the recommendation. We must ensure the rainbow diet on daily basis to sustain a disease-free healthy life.

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