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Role of Fruits in Human Health and Disease Prevention – An Overview

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Abstract: Fruits are rich in carbohydrates, dietary fiber, vitamin B6 and C, carotene, potassium, and with no cholesterol, low in calories and sodium. They have a unique role in a healthy diet. Fruits improve overall health and protect the vital organs of the body and reduce the risks of non-communicable and chronic diseases such as cardiovascular diseases, hypertension, diabetes, gastrointestinal diseases, and obesity. Further, more consumption of fruits can help to protect against eye diseases and improve overall health. Antioxidants from fruits can help to keep body cells and tissues healthy. Therefore, diets rich in fruits are highly recommended for promotion of health. Despite of many peer reviewed scientific studies, there are still gaps in knowledge and information that need to be addressed regarding the micronutrient deficiencies and nutritional disorders occurring due to low consumption of fruits. Aim of the present study was to overcome the knowledge gaps and further provide information on role of fruits in human nutrition and disease prevention. This review provides an insight into the importance of fruits as well as the benefits and progress of nutrition education in improving intake.

Keywords: Chronic diseases, Fruits, Health Benefits, Non-communicable diseases, Nutrition, Vitamins, Minerals

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Introduction

Nutrition is a basic human need and a prerequisite to a healthy life. A proper diet is essential from the very early stages of life for proper growth, development and to remain active (NIN, 2011). Fruits are an important component of a healthy diet and, adequate consumption of fruits on daily basis could help to prevent major chronic diseases such as cardiovascular disease (CVDs) and certain cancers. Non-communicable diseases (NCDs), such as CVDs, cancer, obesity and type 2 diabetes mellitus, currently kill more people every year than any other cause of death (FAO and WHO, 2004; Hiza and Bente, 2007).

Fruits are consumed at all times, and due to their convenient size; they are an excellent between-meal snack (Vicente *et al*., 2009). The World Health Organisation (WHO) (2009) have recorded that, worldwide, about 6.7 million deaths were attributable to inadequate fruit consumption. Daily consumption of fruits is

essential for maintaining good health, longevity and prevents several non-communicable and chronic diseases (Kaur and Aeri, 2019). Wardle *et al*. (2000) and Oguntibeju *et al*. (2013) stated that fruit consumption is influenced by gender, age, income, education and family origin

Weits *et al*. (1970) and Barrett (2007) argued that, fresh fruits may not be consumed for a significant length of time following harvest, during which time nutrient degradation may occur. Despite of many health benefits of fruits, their consumption is below the recommended intake among adults (Morbidity and Mortality Weekly Report, 2010). Results of the study conducted by Pem and Jeewon (2015) suggest that sufficient intake of fruits has been related epidemiologically with reduced risk of CVDs, blood pressure, hypercholesterolemia, osteoporosis, many cancers, chronic obstructive pulmonary diseases, respiratory problems as well as mental health.

Kazi *et al*. (2015) noted that, to maintain the health, we have to take at least 115 g of fruit every day for balanced diet. Recently among consumers, awareness about importance of a balanced diet to prevent the occurrence of chronic diseases has increased significantly. Fruits are one of the important components responsible for health-promotion and/or prevention of disease (Mazzoni *et al*., 2021). Dias *et al*. (2020) have reported that not only the pulp of the fruits is nutritious, but also the peels of the fruits are rich in crude fibers, water-holding capacity (WHC), oil-holding capacity (OHC), good bulking agents and gelling and foaming abilities (Akpata and Akubor, 1999).

There is growing interest and concern among people from all walks of life in foods and their relationship to nutrition and disease (Downey, 1987; Lintas, 1992). Worldwide, inadequate intake of fruits is the major dietary contributor for chronic diseases and premature death (Micha *et al*., 2017). Wang *et al*. (2021) concluded that a higher intake of fruits was associated with cause-specific mortality in US men and women. According to Heiner *et al*. (2012), fruits are extremely important in human nutrition as sources of nutrients and non-nutritive food constituents as well as for the reduction in disease risks.

National Institute of Nutrition (2011) noted that the major food issues of concern are insufficient/imbalanced intake of foods/nutrients. Krauss *et al*. (2000) documented that studies of fruit consumption in relation to overall health are limited. Further, relationship between fruit intake and the incidence of cardiovascular disease, cancer and deaths from other causes was not fully evaluated (Hung *et al*., 2004). Low fruit consumption is an important risk factor for chronic diseases (Hall *et al*., 2009). Tyagi *et al*. (2018) reported that adults should eat at least two kinds of fruit per day and one-half of plate, should contain fruits and vegetables. Adult human must eat 30 g of fruits per day for better health.

Kalmpourtzidou *et al*. (2020) stated that, fruits and vegetables share health benefits due to common phytochemicals, vitamins, minerals and fibers, but bioactive compounds differ widely in composition and ratio between fruits and vegetables. Fruits have higher concentration of sugars than vegetables, while vegetables are more likely to have a higher concentration of fibers and proteins (Appleton et al., 2016). Fruits are indispensable in human diet as they supply essential vitamins (vitamin A, B6, C, E, thiamine, niacin), minerals, and dietary fiber. Fruits are also savouries that provide a pleasing taste (Li, 2012).

According to Dreher (2018), less than 10% of most Western populations consume adequate levels of whole fruits and dietary fiber with typical intake being about half of the recommended levels. Fruits, nuts, dried fruits, and fruit juice are important components for a balanced diet and is essential part of the staple diet due to their benefits for healthy body and preventive effect of numerous diseases. Abobatta (2021) noted that, fruits limit harmful effects on human health; regulate performance of systems, and metabolic and physiological processing; delay infection with chronic diseases; play a vital role in the management of diabetes mellitus; essential

components of the staple diet; and provide nutritional ingredients (vitamins, dietary fiber, carbohydrates, minerals, etc.).

Goldman and Li (2002) reported that fruits have been used in many parts of the world for hundreds of years as herbal medicines with nutritional and therapeutic values. Also, consumers are well-aware that consumption of a variety of fruits is as important as the quantity consumed, as no single fruit provides all of the nutrients needed (Li, 2008). Despite many scientific studies, there are still gaps in knowledge and information regarding the micronutrient deficiencies and nutritional disorders occurring due to low consumption of fruits (WHO, 2003). Present study aims to overcome the knowledge gaps and further research on role of fruits in human nutrition and disease prevention. This review provides an insight into the importance of fruits as well as the benefits and progress of nutrition education in improving intake.

The present paper provides an overview of the definition, classification/types, composition and nutritive value, health benefits and nutritional disorders due to low consumption of fruits.

Definition of Fruits: Table 1 provides information on common definitions of fruits.

Structure of the Fruit:

According to IARC Press (2003), all fruits share basic developmental and anatomical characteristics. Development of fruit is initiated by fertilization, followed by development and differentiation of ovary wall into three layers. The fruit wall is called the pericarp; consisting of three distinct layers such as exocarp, mesocarp, and endocarp. The mature fruit, may also have floral structures like: pedicel, calyx, withered stamens, style, stigma and remnants of the corolla. Tissues other than the ovary wall that form part of a fruit are referred to as 'accessory'. Fruits of pineapple, apple, and strawberry are called accessory (Sinha and Sidhu, 2012).

Literature Search Strategy:

Articles relevant on fruits were searched in EMBASE, Google Scholar, Medline, NCBI, PubMed, Science Direct, Scopus, Web of Science databases. Data and information was collected from the thorough study of the journal articles, research papers, reports and various literatures. The keywords used for reviewing the literature were the ones that refer to the issues concerning the fruits. For literature search, keyword "fruits" is combined with: definition, structure, types, composition and nutritive value, health benefits and nutritional disorders.

Classification/Types of fruits:

Sinha and Sidhu (2012) reported that fruits can be classified based on: origins, growth patterns, postharvest respiration rates and ethylene responses, anatomical features, and consumer's preference (Tables 2-5).

Composition and Nutritive value of vegetables:

Composition of fruits is strongly influenced by the variety and ripeness. The dry matter content of fruits varies in the range of 10% to 20%. Major constituents of fruits are sugar, polysaccharides, and organic acids, with lesser amounts of N-compounds and lipids. Minor constituents include pigments, aroma substances, vitamins and minerals of nutritional importance (Molnar, 1997).

FAO (2003, 2020) recorded that colours of fruits are often linked to the nutrients and phytochemicals they contain (Table 6). Fruits represent a vital source of phytochemicals, dietary fiber, protein, carbohydrates, vitamins, carotenoids, flavonoids, and other components. Therefore, daily consumption of fruits, nuts, dried fruits, and fruit juice provide important components for body health (Abobatta, 2021).

Waleed (2021) reported that fruits, nuts, dried fruits, and fruit juice are important components for a balanced diet and are an essential part of the staple diet. According to Vicente *et al*. (2009), the constituents obtained by the human body from fruits consist of Traditional components

Table 1: Common definitions of fruits

Reference	Definition of fruits
IARC Press (2003)	Edible parts of plants that contain the seeds and pulpy surrounding tissue; have a sweet or tart taste; generally consumed as breakfast beverages, breakfast and lunch side-dishes, snacks or desserts.
Mintah *et al*. (2012)	Edible and fleshy seed-associated structures of certain plants, which could be sweet (apples, oranges, grapes, strawberries, juniper berries and bananas) or non-sweet (lemon and olives) in their raw forms.
Sinha and Sidhu (2012)	Any edible part of a plant with a sweet taste and pleasant flavour, corresponding to most edible fleshy fruits in the botanical sense.
Health Fact Sheet (2014)	Ripened ovary of a flower; a juicy and edible structure such as an apple, plum, peach, or grape.
Kandasamy and Shanmugapriya (2015)	Fruit is the fleshy growth that arises from the ovary of a flower and may not necessarily include any other structures or fruit is the edible product of a plant or tree that includes the seed and its envelope and can typically be described as juicy, sweet, and pulpy.
Amao (2018)	The edible part of a plant that consists of the seeds and surrounding tissues.
FAO (2020)	Edible parts of plants (seed-bearing structures), either cultivated or harvested wild, in their raw state or in a minimally processed form.
Rezaei *et al*. (2020)	A true fruit or eucarp is a mature or ripened ovary, developed after fertilization, e.g., Mango, Maize, Grape etc.

Table 2: Classification of fruits based on their origins and major production areas

Types of fruits	Salient features fruits	Examples of fruits
Temperate fruits	• Crops are deciduous. • Cultivated in winter in chilling temperature.	• Apple, Blueberry, Cherry, Fig, Grape, Kiwifruit, Nectarine, Peach, Pear, Plum, Pomegranate, Strawberry
Subtropicalfruits	• Tolerance very low or chilling temperature.	• Avocado, Cherimoya, Citrus fruit, Loquat, Lychee,
Tropical fruits	• Mostly originated in tropical rain forests. • Do not tolerate temperature below 10ºC.	• Banana, Pineapple, Mango, Papaya, Carambola (star fruit), Guava, Passion fruit, Mangosteen, Longan, Jackfruit, Durian, Rambutan, Sapota.

Table 3: Classification of fruits based on respiration rates and ethylene responses

Types of fruits	Salient features fruits	Examples of fruits
Nonclimacteric fruits	• Consistent and low respiration rate at maturity. • Respiration rate responds to temperature.	• Asian pear, Blackberry, Blueberry, Carambola (star fruit), Cherry, Chinese jujube, Cranberry, Grape, Grapefruit, Lemon, Lime, Loquat, Lychee, Orange, Pineapple, Pitaya, Pomegranate, Rraspberry, Rumbutan, Strawberry,
Climacteric fruits	• Increase in respiration rate in maturation. • Little amount of ethylene is produced at maturity.	• Apple, Apricot, Avocado, Banana, Bread fruit, Cherimoya, Durian, European pear, Guava, Indian jujube, Jackfruit, Kiwifruit, Mango, Papaya, Passion fruit, Peach, Persimmon, Plantain, Plum, Tomato.

Table 4: Botanical classification of fruits (IARC Press, 2003)

Types of fruits	Salient features fruits	Examples of fruits
Simple fruits	• **Development:** When a single fruit develops from a single ovary of a single flower, it is called a simple fruit. • **Types:** Simple dry fruits or Simple fleshy fruits.	
Simple dry fruits	• Fruit with dried pericarp. • Either 'dehiscent' (opening to discharge seeds), or 'indehiscent' (not opening to discharge seeds'.	• **Legume/Pod:** Developed from a simple carpel and dehisces on two sides. e.g. Peas, beans, and Peanuts. • **Nut:** Indehiscent with one seed protected by hardened ovary wall. e.g. Chestnut, Hazelnut or filbert. • **Other Examples:** Achene, Capsule, Cypsela, Caryopsis, Fibrous Drupe
Simple fleshy fruits	• Pericarp is fleshy at maturity. • Pericarp and carpel are fused together.	• **Berry:** Seeds and pulp are produced from a single ovary. Entire ovary wall ripens into an edible pericarp. e.g. Grape, Kiwifruit, Banana, Tomato, etc. • **Drupe:** Fruit with soft and fleshy exocarp, mesocarp and pericarp. Hard endocarp and enclose the seed. Developed from a single carpel. Examples: Stone fruits, Mango, Coffee. • **Other Examples:** Pome, Hesperidium, Pepo
Compound Fruits	• Fruit derived from multiple ovaries within a single flower or from multiple flowers, each bearinga single ovary.	
Aggregate fruit	• Groups of fruit lets developed from multi-carpellary, apocarpous ovary of single flower. • Also called etaerio, i.e. aggregate of fruit lets.	• Each free carpel develops into a fruitlet which is known as follicle. • Many follicles of a flower make it etaerio, i. e. etaerio of follicle. • Exampless – Calotropis, Catharanthus
Composite/ Multiple fruit	• Develop from the complete inflorescence, and are called infructescence. • Types: Syconus and Sorosis.	• **Syconus**: Fruits develop from hypanthodium inflorescence and are achene type. Fleshy receptacles form the edible part. Example - Fig (Ficus). • **Sorosis:** Fruit develops from spike, spadix or catkin inflorescence. Entire inflorescence appears as one fruit. Examples - Jackfruit, Pineapple.
Accessory fruit	• Fleshy part is derived from the accessory tissues of the flower. • Also called 'false fruits' or 'pseudocarps'.	• Examples -Strawberries, Pome, Fig.

(carbohydrates, dietary fiber, lipids and fatty acids, organic acids, proteins, vitamins and water);Antioxidants (ascorbic acid, carotenoids, phenolic compounds, tocopherols and tocotrienols); and Minerals (macronutrients: Ca, K, Mg, N, and P; micronutrients: Cl, Co, Cu, F, Fe, I, Mn, Na, S, Se, and Zn) (Table 7). Fruits play an important role in human nutrition and health, particularly as sources of vitamin C, thiamine, niacin, pyridoxine, folic acid, minerals and dietary fibre (Barrett, 2007; Oguntibeju *et al*., 2013).

Traditional components:

❖ *Carbohydrates*:

Lintas (1992) reported that , fruit vary widely in their carbohydrate content (between 1.5 - 6% or

Table 5: Culinary classification of fruits (Kandasamy and Shanmugapriya, 2015)

Types of fruits	Salient features fruits	Examples of fruits
Fruits	• Any edible part of a plant with a sweet taste and pleasant flavour.	• Apple, Banana, Cherry, Dates, Figs, Grapes, Guava, Jackfruit, Kiwifruit, Lemon, Mango, Orange, Papaya, Pineapple, Pomegranates, Strawberries, Sweet lime, Water melon, etc.
Fruits used as Vegetables	• Fruits those are not palatable or sweet when consumed raw. • Offer savory taste when cooked or processed.	• Tomato family (Solanaceae) • Gourd family (Cucurbitaceae) • Pea family (Fabaceae) • Cucumber, Lady's finger, Chili, Snow peas, Sweet corn, Tomato, Waxgourd, Winter squash, Pumpkin.
Nuts	• Seeds and dry fruits producing oil-rich kernels within hardened seed coats. • Plants in Fagaceae and Betulaceae produce true nuts.	• **Culinary Nuts:** Almond, Brazil nut, Cashew nut, Chestnut, Hazelnut, Lychee nut, Macadamia nut, Peanut, Pecan, Pistachio, Walnut,
Cereals or grains	• Fruits cultivated for their edible parts. • Daily sustenance and staple food.	• Buckwheat, Maize, Rice, Sweet corns, Wheat,

Table 6: Colours of the fruits and nutrients and phytochemicals they contain

Colour	Nutrients and Phytochemicals	Examples of fruits
Brown/ white	• Phytochemicals with antiviral and antibacterial properties. • Potassium.	Banana, Durian, Jackfruit, White peach, Brown pear.
Green	• Phytochemicals with anti-cancer properties.	Green apple, Avocado, Green grape, Kiwifruit, Lime.
Orange/ yellow	• Contain carotenoids. • Keep eyes healthy.	Apricot, Grapefruit, Lemon, Mango, Melon, Nectarine, Orange, Papaya, Peach, Pineapple.
Purple/ blue	• Antioxidant properties. • Reduce the risks of cancer, stroke and heart disease.	Blackberry, Blueberry, Purple grape, Plum, Passion fruit.
Red	❖ Lower the risk of cancer. ❖ Improve heart health.	Red apple, Cherry, Red grape, Red guava, Strawberry, Watermelon

50% to 80% of the total dry weight). They functions as storage of energy reserves and structural framework of cells. Carbohydrates from the fruits consists of mono saccharaides (glucose, galactose, mannose, arabinose, xylose, rhamnose, fructose, and galacturonic and glucuronic acid), oligosaccharaides (sucrose) and polysaccharides (cellulose, hemicellulose, pentosans, andpectins) (Asp,1994; Molnar, 1997).

❖ *Dietary fiber*:

Dietary fiber consists of non-digestible carbohydrates and lignin macromolecules that are intrinsic and intact in plants. The main components included as fiber are Cellulose, Hemicelluloses, Lignin, Pectins, Resistant starch, and Non-digestible oligosaccharides. Benefits of dietary fiber intake are modulation of function of the intestinal tract. Further, total

Table 7: Mean Composition and Nutritive value of fresh fruits (Source: Lintas, 1992; Slavin and Lloyd, 2012)

Nutrient	Content (content/100 g edible matter)
Water (g)	80.0 – 95.0
Proteins (g)	0.5 – 1.5
Fats (g)	0.1 – 1.0
Carbohydrate (g) (Fructose, Glucose, Sucrose)	1.5 – 26.0
Dietary fiber	0.2 – 6.4
Energy (kcal)	6.0 – 66
Minerals	
Ca (mg)	6.0 – 50.0
Fe (mg)	0.3 – 1.0
K (mg)	110 - 450
Na (mg)	5 - 15
Vitamins	
ß-carotene (mg)	0.2 – 2.0
C	10 - 90
B6	0.03 – 0.35

fruit consumption was inversely associated with colorectal cancer risk and increased dietary fiber intake is important in the prevention of some diseases (Institute of Medicine, 2001).

❖ *Lipids and fatty acids*:

In fruits, the fat content is usually below 1% and varies with the product. Fat content on a dry mass basis in few fruits are avocado: 35–70%; olive: 30–70%; grape: 0.2%; banana: 0.1%; and apple: 0.06%. In fruits, lipids are present in the form of triglycerides or phospholipids (Vicente *et al*., 2009).

❖ *Organic acids*:

Organic acids are the principal compounds in the fruits producing a sour sensation or acidity (Sinha and Sidhu, 2012). Vicente *et al*. (2009) argued that, generally, citric and malic acids are present abundantly in fruits. Also large amounts of tartaric acid occur in grapes. Malic acid is the major component in oranges and apples. The acid content of fruits generally decreases during maturation. Other acids such as benzoic acid occur in cranberries, quinic acid in bananas and chlorogenic acid in potatoes. Organic acids are important in the sugar to acid ratio, which affects the flavour of fruits. Also, the distribution of acids within a fruit is not uniform.

❖ *Proteins*:

Protein content of the fresh fruit is about 0.5 – 1.5%. Fruits are low in proteins and the protein content of fresh fruits is calculated by multiplying the total nitrogen content by a factor of 6.25. Pears and oranges are rich in proline, and black and red currants in alanine (Vicente *et al*., 2009).

❖ *Vitamins*:

According to Rodriguez-Amaya (2001), fresh fruits have wide range of vitamins, such as fat-soluble (A, D, E and K) and water-soluble (B group and C) molecules. The vitamins present in fruits make an important contribution to human nutrition, and are important in normal body performance.

❖ *Water*:

In fruits, water is the most abundant single

component and it may account for up to 90% of the total mass. The maximum water content varies between individual fruits, because of structural differences and varied cultivation conditions (Vicente *et al*., 2009).

Antioxidants:

Antioxidants are compounds able to oppose cellular oxidation. Diets rich in fruits reduce the chances of cardiovascular disease and some

chronic and degenerative diseases associated with oxidative damage. Inclusions of the fruits in the diet help to eliminate certain toxins and show protective effects. Antioxidants are present in all organs of plants and include ascorbic acid, carotenoids, vitamin E and phenolic compounds (Dragsted, 2003).

❖ *Ascorbic acid*:

Ascorbic acid is one of the main antioxidant present in fruits and is important in human nutrition. It neutralizes the reactive oxygen species (ROS) and prevents the diseases (Asami *et al*., 2003).

❖ *Carotenoids*:

Fruits are the main sources of carotenoids in the diet. Antioxidant properties of the carotenoids were mainly determined by the conjugated double bonds present in carotenoids. Due to the antioxidant properties, carotenoids plays a major role in prevention of some diseases (Rao and Rao, 2007).

❖ *Phenolic compounds*:

Phenolic compounds are derived from aromatic amino acids, phenylalanine and tyrosine. They act as antimicrobials and provide protection against UV-radiation. They also contribute in pigmentation of fruits, astringency and bitter taste of some products. In fruits, phenolic compounds are present in low concentrations and also accumulate in the peel more than in the pulp of fruits. They influence several cellular processes and are subdivided into subclasses, such as phenolic acids, flavonoids and other compounds (coumarins, lignans, lignin, stilbenes, and tannins).

❖ *Tocopherols and tocotrienols*:

Tocopherols and tocotrienols include fat-soluble compounds with high antioxidant capacity and are grouped as 'vitamin E'. They can prevent the risk of some non-communicable diseases and chronic and degenerative diseases. Deficiency of tocopherols and tocotrienols results in stunted growth (Mittler, 2002; Tyagi *et al*., 2018).

Minerals:

Dris *et al*. (1999) and Erturk *et al*. (2006) stated that, fruits are considered as the "nutrient-dense foods" since they provide substantial amounts of macronutrients (Ca, K, Mg, N, and P) and micronutrients (Cl, Co, Cu, F, Fe, I, Mn, Na, S, Se, and Zn). Minerals have both direct and indirect effects on human health with respect to nutrition. Even though fruits provide a milieu of phytochemicals, non-nutritive substances that possess health protective benefits, they are not recognized as primary sources of mineral intakes from a nutritional point of view (Kandasamy and Shanmugapriya, 2015).

Health benefit of fruits:

FAO (2020) reported that, green, yellow, orange, red or purple fruits keep us healthy and add variety, taste and texture to our diets. A monotonous diet is not only unhealthy for humans: it is also unhealthy for the planet because it can result in monocultures and a loss of biodiversity. GBD 2017 Diet Collaborators (2019) noted that, insufficient intake of fruits is estimated to cause around 14% of deaths from gastro-intestinal cancer worldwide, about 115% of those due to ischemic heart disease, and about 9% of those caused by stroke. Some of the health benefits of vegetables are presented in Table 8.

Therapeutic benefits of fruits:

According to Ebabhi and Adebayo (2021), 'Phytochemicals' or 'secondary metabolites' are non-nutritive chemical compounds produced by plants via several chemical pathways. Large numbers of phytochemicals are beneficial to the function of human cells and to improve health (Table 9). Phytochemicals from fruits, give colour, flavour, and aroma to plants. They are of different types such as Anthocyanins, Carotenoids, Flavonoids, Isothiocyanates, Lutein and zeaxanthin. Phytochemicals play important role in human health and it was proved that people who eat mainly the plant based diets, shown to have significantly lower rates of certain types of cancers and heart disease (Talalay and Fahey, 2001).

Table 8: Health benefits of fruits

Reference	Health benefits
Hung *et al*. (2004), PBHF(2015)	Reduces the risk of: • Asthma, Cancer, Chronic Inflammatory Bowel Diseases (IBD). • Chronic Obstructive Pulmonary Disease (COPD). • Coronary Heart Disease (CHD), Dementia, Eye diseases. • Hypertension, Obesity, Osteoporosis. • Rheumatoid Arthritis (RA), Stroke, Type 2 Diabetes Mellitus.
Slavin and Lloyd (2012)	• Lower incidence of cardiovascular disease and obesity. • Supply vitamins and minerals to the diet. • Sources of phytochemicals: Antioxidants, phytoestrogens, and anti-inflammatory agents.
Boeing *et al*. (2012); Smith et al (2022)	• Reduces the risk of hypertension, CHD, stroke and cancer. • Prevent body weight gain. • Reduces the incidences of type 2 diabetes mellitus. • Lowers the risk of eye diseases, dementia and osteoporosis. • Prevention of asthma, COPD and RA.
Oguntibeju *et al*. (2013)	• Reduce risk of cancer, CHD, stroke and cataract formation. • Prevent oesophageal, stomach, pancreatic, bladder and cervical cancers.
Kandasamy and Shanmugapriya (2015)	• Source of nutrients, vitamins, minerals, organic acids and anti-oxidants. • Lower incidence of cardiovascular disease and obesity. • Smooth bowel movements and relief from constipation ailments. • Protection against cancers, aging, infections, etc. • Boost the immunity level. • Protect against wrinkling of skin, hair-fall, and memory loss. • Reduce the risks of age-related macular degeneration of the retina in the eyes, Alzheimer's disease, colon cancers, weak bones (osteoporosis), etc.
Amao (2018)	• Improve overall health and protect the vital organs of the body. • Controls weight and promote healthy skin and hair.
Dreher (2018)	• Protection against colonic gastrointestinal health. • Promote long-term weight management. • Reduce risk of CVD, type II diabetes and metabolic syndrome. • Defend against colorectal and lung cancers. • Improve odds of successful aging. • Reduce the severity of asthma and chronic obstructive pulmonary disease. • Enhance psychological well-being. • Lower the risk of depression. • Enhance bone mineral density in children and adults. • Help to attenuate autism spectrum disorder severity.
Kaur and Aeri (2019)	• Good health and the longevity. • Reduce the risks of non-communicable and chronic diseases: cardiovascular diseases, hypertension, diabetes, gastrointestinal diseases, and obesity.
Abobatta (2021); Techane (2022)	• Reduce the negative effects induced by free radicals. • Decrease inflammation and maintain body health. • Prevent various chronic diseases (CVD, NCDs).

Table 9: Therapeutic benefits of Phytochemicals in vegetables

Reference	Therapeutic benefits of Phytochemicals
Talalay and Fahey (2001)	• Reduces the risk of cancer. • Aids in digestion and prevents constipation. • Reverses the aging process and prolongs life. • Reinforces stamina and prevents fatigue. • Repairs damage or dry skin. • Prevent CVD, stroke, hypertension, and diabetes.
Ulger *et al*. (2018)	• Have antiviral, anticancer and antibacterial properties. • Reduce the risk of chronic diseases.. • Strengthen the immune system. • Protect against carcinogenic substances. • Reduce inflammation and oxidative stress that causes cancer.
Ebabhi and Adebayo (2021)	• Help the body to fight against diseases. • Reduce the incidence of occurrence of diseases. • Inhibit growth of cancer cell. • Reduce risk of CVD and boost immunity. • Help to lower the blood pressure. • Promote the eye health.
Kibr (2022)	• Prevent NCDs (cancer, heart disease, etc). • Treat cancer by neutralizing free radicals. • Block or suppress active carcinogens or tumour promoters. • Health-promoting functions.

Conclusion

The nutritional value of fruits depends on their composition, which varies according to species, cultivar and maturity stage. Even though, composition of fruits includes a great number of metabolites, no single fruit might be rich in all these constituents. Since fruits are rich in carbohydrates, dietary fiber, vitamin B6 and C, carotene, potassium, and with almost no cholesterol, low in calories and sodium; as a result, fruits have a unique role in a healthy diet. They improve overall health and protect the vital organs of the body along with reduced risks of non-communicable and chronic diseases such as cardiovascular diseases, hypertension, diabetes, gastrointestinal diseases, and obesity. Present study recommends daily intake of fruits for better health of general public and also for prevention of micronutrient deficiency, especially for children, pregnant women and elderly people.

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