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Fruits and vegetables as Superfoods: Scope and demand

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Abstract

“Superfoods” has gained increasing usage and attention recently with the marketing strategy to promote the extraordinary health benefits within the human body and play an important role in the direction of prevention degenerative diseases and health promotion. The possible beneficial properties of functional foods are due to their content in bioactive ingredients like Vitamins and phytochemicals (phenolic acids, flavonoids, proanthocyanidins, hydrolysable tannins, carotenoids, and anthocyanins) with specific biological properties and effects within the human body. Fruits and vegetables were important then for your growth and wellbeing, but as we begin to age, they become increasingly vital. In many cases, these are the foods that play an important role in reducing the risk of serious conditions and diseases. In fact, there are a number of fruits and vegetables that have been classified as “superfoods.” This signifies that they represent an all-natural source of vitamins, minerals, and other nutrients conducive to healthy living demonstrated health benefits, including antioxidant, anti-inflammatory, prebiotic, anti-microbial, chemopreventive, and hypocholesterolaemic activities. Recently, the appearance of a multitude of chronic degenerative diseases such as cardiovascular disease, diabetes, obesity, osteoporosis and cancer, has led to ways of defending human health through the adoption of appropriate dietary patterns. Hence, superfoods provided that they fit inside hygiene and balanced nutrition, are suggested as a potential solution to reinforcing the prevention strategy, avoiding the need for therapy, with the aim of promoting the health of the population.

Keywords: Fruits, vegetables, demand, Superfoods, anti-inflammatory

Introduction

Human nutrition, process by which substances in food are transformed into body tissues and provide energy for the full range of physical and mental activities that make up human life. Health is much more than the absence of disease. It is a positive quality, emphasizing physical, social, intellectual, emotional, and spiritual well-being. The ultimate goal of nutritional science is to promote optimal health and reduce the risk of chronic diseases such as cardiovascular disease and cancer as well as to prevent classic nutritional deficiency diseases such as kwashiorkor and pellagra.

Nutrition for human health

Nutrition is a critical part of health and development. Better nutrition is related to improved infant, child and maternal health, stronger immune systems, safer pregnancy and childbirth, lower risk of non-communicable diseases (such as diabetes and cardiovascular disease), and longevity. Healthy children learn better. People with adequate nutrition are more productive and can create opportunities to gradually break the cycles of poverty and hunger (Southan, 2000) [45]. Malnutrition, in every form, presents significant threats to human health. Today the world faces a double burden of malnutrition that includes both under nutrition and overweight, especially in low- and middle- income countries. Optimum nutrition, providing all nutrients in both kind and amount, is the cornerstone of good health and the cutting edge of prevention.

Role of fruits and vegetables in human nutrition

Fruit and vegetables should be an important part of your daily diet. They are naturally good and contain vitamins, minerals, Low in fat, salt and sugar, Good source for dietary fiber and Contain phytochemicals that can help to keep you healthy. They can also help protect against some diseases, Provide well balanced, Healthy and active lifestyle (Wargovich, 2000) [49]. A high intake of fruit and vegetables can help you to reduce obesity and maintain a weight and also they lower your cholesterol Lower your blood pressure.

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The World Health Organisation and Food and Agriculture of the United Nation reports recommend adults to consume at least five servings of fruits and vegetables per day excluding starchy vegetables.

India is facing a great problem of malnutrition. The malnutrition is the single largest cause to the high rate of infant and child mortality and morbidity in India. Hence, malnutrition is responsible for the development of “malnutrition cancer” as a consequence of which a huge mortality occurs every year in human beings, especially in children all over the world. Hence, the individuals should be advised to take sufficient nutritious diets, including more amounts of various fruits and vegetables (WHO, 2018) [52]. The protective and curative actions of fruits and vegetables against cancer have been attributed on the ground of several scientific reports. It has been suggested that persons wishing to reduce their risk of cancer must eat several pieces of fruits and several portions of vegetables every day. Consumption of various fruits and vegetables play a significant role against malnutrition cancer. It is distinct that medicinal plants, including fruits and vegetables have versatile immune modulatory and anticancer activities. Consumption of large amounts of fruits and vegetables can prevent the development of cancer. Many doctors recommend that people wishing to reduce risk of cancer eat several pieces of fruits and several portions of vegetables every day.

Super foods

Super foods refer to nutrient-rich food items that are beneficial for maintaining good health and wellbeing or Great biological value due to satisfactory bioavailability and bioactivity within the body due to a variety of bioactive ingredients they contain (Wolfe, 2009) [51]. Super foods plays important role in increase vitality of the human body and improve the overall health by strengthening the immune system.

Fruits and vegetables were important then for your growth and wellbeing, but as we begin to age, they become increasingly vital. (Crowe *et al.*, 2015) [9] state that in many cases, these are the foods that play an important role in reducing the risk of serious conditions and diseases. In fact, there are a number of fruits and vegetables that have been classified as “superfoods”. This signifies that they represent an all-natural source of vitamins, minerals, and other nutrients conducive to healthy living demonstrated health benefits, including antioxidant, anti-inflammatory, prebiotic, anti-microbial, chemopreventive, and hypocholesterolaemic activities (Holmes, 2015) [24].

The most important bioactive components of super foods which have been proven to be beneficial to human body are:

- Polyunsaturated fatty acids (ω -3, ω -6),
- Vitamins
- Polyphenolic compounds
- Essential amino acids
- Sulphur compounds
- Polysaccharides and various enzymes

Superfood market growth

The global superfoods market size was estimated at USD 137.0 billion in 2018 and is projected to ascend at a CAGR of 5.9% over the forecast period. Growing consumer interest in a healthy diet and wellness benefits has led to a thriving food & beverage industry in the recent past and this trend is expected to continue over the forecast period. This, in turn, is projected

to propel the demand for superfoods in the coming years. Increasing healthcare costs, growing geriatric population, food innovations, changing lifestyle, and medical discoveries have benefitted the demand for superfoods and consequently the overall market growth. Ascending demand for natural, nutrient-rich food containing vitamins and essential minerals is further boosting the market for superfoods. Growing concerns in the U.S. regarding obesity and overall health are also contributing to the market growth.

Globally, fruits & vegetables type segment is set to experience favorable growth driven by factors such as rising middle-class population, upsurge in disposable income, rapid urbanization, changing consumer lifestyle, and a rising popularity of veganism. This, in turn, is projected to drive the market for superfoods (Warren, 2014) [50]. The major trends observed in the aforementioned segment include the rise of branding, technological advancements, and the advent of online grocery shopping. However, the growth of this budding segment is restrained by challenges such as volatility in prices, adverse weather conditions, and quality issues.

Report forecast

The major factors contributing to the growth of the global superfood market include the increasing health awareness, rapidly growing old age population, and the high demand for fruits. In terms of the superfood, the demand for fruits is increasing rapidly. It has been observed that despite the fluctuations in prices, the demand for food is drastically growing. Moreover, due to urbanization, high disposable income, and changing lifestyles of individuals will positively influence the demand of the market. Consumers are more inclined toward convenient and healthy foods, thereby saving their time and money at the same time. The individuals now prefer to have fruit-based drinks and meals in busy working schedule as the fruit-based meals take less time to prepare. Thus, the rising demand for food is boosting the growth of the market globally.

This report forecasts revenue and volume growth at global, regional & country levels and provides an analysis of the industry trends in each of the sub-segments from 2014 to 2025. For this study, Grand View Research has segmented the global superfoods market report based on type, application, and region:

The global Superfood market has been segmented on the basis of type, application, and region

- Based on type - The market is segmented into fruits, vegetables, grains & cereals, herbs & roots, and others.
- Based on application - The market is segmented into bakery & confectionery, snacks, beverages, and others.
- Based on distribution channel- The market is segmented into supermarkets/hypermarkets, traditional grocery stores, specialty superstores, online, and others.

Functions of Bioactive compounds in human diet

Bioactive compounds are defined as components of food that have an impact on physiological or cellular activities in the humans or animals that consume such compounds (Kris-Etherton *et al.*, 2002) [28]. They are mainly found in fruits and vegetables; have antioxidant, anti-inflammatory, and anti-carcinogenic effects; and can be protective against various diseases and metabolic disorders. Such beneficial effects

make them good candidates for development of new functional food with potential protective and preservative properties.

Polyunsaturated fatty acids

Polyunsaturated fat is a type of dietary fat. It is one of the healthy fats, along with monounsaturated fat. Polyunsaturated fats can help lower your LDL (bad) cholesterol. Cholesterol is a soft, waxy substance that can cause clogged or blocked arteries (blood vessels). Having low LDL cholesterol reduces your risk for heart disease (Lee *et al.*, 2009) ^[29].

The two major classes of polyunsaturated fats are omega-3 and omega-6 fatty acids.

Omega-3 fatty acids are good for your heart in several ways. They help

- Reduced risk of cardiovascular disease.
- Reduced risk of death if you have cardiovascular disease.
- Reduced risk of sudden cardiac death caused by an abnormal heart rhythm.
- Reduced risk of blood clots because omega-3 fatty acids help prevent blood platelets from clumping together.
- Keeping the lining of the arteries smooth and free of damage that can lead to thick, hard arteries. This helps keep plaque from forming in the arteries.
- Lowering triglyceride levels by slowing the rate they form in the liver. High levels of triglycerides in the blood increase the risk of heart disease.
- Less inflammation: Atherosclerosis (hardening of the arteries) is thought to involve your body's inflammatory response. Omega-3 fatty acids slow production of substances that are released during the inflammatory response.

Omega-6 fatty acids

Omega-6 fatty acids are polyunsaturated fatty acids that perform essential functions in the human body. The most abundant member of this family in food and in the body is linoleic acid. They help protect the heart from lapsing into potentially deadly erratic rhythms. They ease inflammation. They inhibit the formation of dangerous clots in the bloodstream. (Meyer *et al.*, 2003) ^[33] suggested they also lower levels of triglycerides, the most common type of fat-carrying particle in the blood. Early research suggests that infants fed formula supplemented with an omega-6 fatty acid called arachidonic acid and an omega-3 fatty acid called docosahexaenoic acid (DHA) for the first year of life have a lower risk of diarrhea.

Vitamins

Vitamins are essential trace substances to maintain normal physiological function of human body. The majority of vitamins cannot be synthesized by human body and only can be up taken from foods. Vitamin C and vitamin E are the most well-known antioxidants and extensively studied. Vitamin C (ascorbic acid) is mainly found in fresh vegetables and fruits (Seddon *et al.*, 1998) ^[43]. The vitamins present in fruits and vegetables make an important contribution to human nutrition, as they have specific functions in normal body performance.

Vitamin C - Ascorbic Acid

In recent years, a large number of basic and clinical studies

have discovered that vitamin C has the protective role in a series of diseases caused by oxidative stress, such as cardiovascular disease, cancer and cirrhosis. The recommended dietary allowance of vitamin C for men is 75mg daily, while the recommended dietary allowance for young women is higher, at 90mg daily. Vitamin C can act as the superoxide scavenger in primary hypertension to eliminate the symptoms of patients. By providing continuous medication of vitamin C at the dosage of 500 mg to cardiovascular patients for 10 weeks, the content of low-density lipoprotein (LDL) in blood is obviously reduced (Naidu, 2003). LDL is the major component causing oxidative damage to blood vessel, suggesting that vitamin C can execute a treatment effect on cardiovascular disease.

Vitamin E

Vitamin E is a kind of fat-soluble vitamin, also known as tocopherol. Vitamin E has a very extensive function of protecting biological membrane in human body and nucleic acids in cells from the attacking of free radicals. Vitamin E is rich in nuts such as almonds, walnuts, vegetable oil, kiwi fruits and green vegetables. Vitamin E is found to have suppressive function to tumors. Samples from 5,000 women and reported that the content of vitamin E in women with breast cancer is significantly lower than that in the normal group (4.7 mg/L vs. 6.0 mg/L), suggesting that vitamin E can reduce the risk of breast cancer (Nikki *et al.*, 2003). Vitamin E deficiency results in stunted growth. Even though the levels of tocopherol in broccoli and leafy vegetables are lower than in fat-rich products, they are good sources compared to other fruits and vegetables.

Carotenoids

Carotenoids – also known as carotenes – belong to the group of lipid-soluble hydrocarbons; and their oxygenated derivatives are called xanthophyll. The name ‘carotenes’ is derived from the red colour of carrots; but they are commonly distributed in various other plants also as they are found in green leaves, in most yellow and red fruits, and many roots. Carotenoids exert protective effects against several kinds of cancers, in addition to benefits to vision and skin. Carotenoid pigments, which are abundant in many fruits and vegetables, have been studied for their diverse roles in phytochemistry and phytomedicine. Several studies have shown that carotenoids are associated with a diminished risk for different kinds of cancer such as lung cancer, prostate cancer, breast cancer, and head and neck cancers. Based on epidemiological studies a positive link is suggested between higher dietary intake and tissue concentrations of carotenoids and lower risk of chronic diseases. (Guest *et al.*, 2012) ^[20]. The most important include β -carotene, α -carotene, lycopene, lutein, zeaxanthin, β -cryptoxanthin, all present in human plasma. The β -carotene and lycopene have been shown to be inversely related to the risk of cardiovascular diseases and certain cancers. Importantly, the β -carotene is a precursor of vitamin A which is needed for robust immune system, healthy skin and mucous membranes, and good eye health and vision. Lutein protects against uterine, prostate, breast, colorectal and lung cancers. They may also protect against risk of digestive tract cancer. Recent studies are also showing that carotenoids may mediate their effects via other mechanisms such as gap junction communication, cell growth regulation, modulating gene expression, immune response and as modulators of Phase I and II drug metabolizing enzymes.

Lycopene

Lycopene is one of the powerful antioxidant carotenoid compounds. It is naturally present in tomatoes and pink grapefruit, and is well-known in promoting health through prevention of such chronic diseases as cancer and CVD. While there are rare studies on its effect on diabetes (β -cells of pancreas). However, in humans, various studies investigating the effects of high consumption of lycopene on reducing the risk of developing type 2 diabetes have yielded equivocal results. Although (Arab *et al.*, 2012) studied, the antioxidant properties of lycopene are thought to be primarily responsible for its beneficial properties, evidence is accumulating to suggest other mechanisms such as modulation of intercellular gap junction communication, hormonal and immune system and metabolic pathways may

also be involved. The antioxidant capacity of lycopene offers protection against gamma-radiation induced damage to cells. Lycopene has a very strong antioxidant capacity, plays a role in cell communication, and there is experimental evidence that it protects against prostate cancer, cardiovascular disease.

Essential Amino acids

Amino acids are organic compounds that combine to form proteins. Amino acids and proteins are the building blocks of life (Hou *et al.*, 2018) ^[25]. Amino acids can also be used as a source of energy by the body. Essential amino acids cannot be made by the body. As a result, they must come from food. The 9 essential amino acids are: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and Valine.

Table 1: Health benefits of Essential amino acids

Essential amino acids	Health Benefits	Sources
Histidine	Ensure the transmission of messages from the brain to various parts of the body and Useful for treatment of mental disorders	Apple, pomegranate, beets, carrots, celery, cucumber, garlic, radish, spinach, turnip greens.
Tryptophan	Though often associated with causing drowsiness. It's needed to maintain proper nitrogen balance and is a precursor to serotonin, a neurotransmitter that regulates your appetite, sleep and mood	Bananas, dried dates, milk, cottage cheese, meat, fish, turkey and peanuts.
Lysine	Lysine plays major roles in protein synthesis, hormone and enzyme production and the absorption of calcium. It's also important for energy production, immune function and the production of collagen and elastin.	Green beans, lentils, soybean, spinach and amaranth.
Methionine	Methionine plays an important role in metabolism and detoxification. It's also necessary for tissue growth and the absorption of zinc and selenium, minerals that are vital to your health	It is found in fish, whole grains, and dairy.
Valine	Helpful in treating liver and gallbladder disorders, and it is good for correcting the type of severe amino acid deficiencies that can be caused by drug addiction	Grain, meat, mushrooms, peanuts, and soy proteins
Leucine	Help healing of skin and bones. It may increase muscle growth and lean body mass. It may increase production of human growth hormone (HGH). It may help control blood sugar	cottage cheese, sesame seeds, peanuts, dry lentils, chicken, and fish
Threonine	Threonine is a principal part of structural proteins such as collagen and elastin, which are important components of the skin and connective tissue. It also plays a role in fat metabolism and immune function	dairy, beef, poultry, eggs, beans, nuts, and seeds
Isoleucine	Blood sugar regulation, muscle development and repair, hemoglobin development, and energy regulation.	Eggs, fish, lentils, poultry, beef, seeds, soy, wheat, almonds.
Phenylalanine	Depression, attention deficit-hyperactivity disorder (ADHD), Parkinson's disease, chronic pain, osteoarthritis, rheumatoid arthritis	Almonds, avocados, lima beans, peanuts, and seeds.

Polyphenol compounds

Polyphenols are naturally occurring compounds found largely in fruits, vegetables and they have relevance in the quality of plant derived foods (Manach *et al.*, 2005) ^[30]. These phenolic compounds vary in chemical nature and biological properties which possess anti-oxidant, anti-inflammatory, anti-tumoral and oestrogenic activities anti-carcinogenic, anti-neurodegenerative, anti-diabetic, anti-viral, skin photoprotective, anti-allergic, anti-platelet, anti-aging, cytoprotective and DNA-protective properties might have the potential in the prevention of coronary and diseases and cancer. Some of the polyphenol compounds include

Phenolic acids

Phenolic acids, the main polyphenols in the human diet, are bioavailable. Two classes of phenolic acids can be distinguished depending on their structure: derivatives of benzoic acid and derivatives of cinnamic acid. Phenolic acids are beneficial to human health due to their potential antioxidants and avert the damage of cells resulted from free-radical oxidation reactions.

Flavonoid

Flavonoids form the largest and a diverse group of bioactive compounds, known as phytonutrients or phytochemicals, which are the major constituents of polyphenols and they can be considered more into flavanols, flavones, isoflavones, flavanones, anthocyanidins, flavanonols, and flavans (catechins and proanthocyanidins). Each subgroup and its type of flavonoids have a distinctive range of plant source, functions, and health benefits. This collection of plant bioactive compounds is known to possess benefits to human health due to their identified antioxidant and anti-inflammatory effects. Flavonoids exist in every fruit and vegetable, and along with carotenoids, they are responsible for their unique colors. There are more than 6,000 different identified types of flavonoids which are beneficial in human diet.

Flavonoids are ample in a range of fruits and vegetables. Its major sources include berries, leeks, ginger, grapefruit, carrot, apple, onion, broccoli, cabbage, kale, tomato, lemon and red wine are also bursting with health-giving benefits. Flavonoids are beneficial in this regard as they act as influential

antioxidants; they also neutralize free radicals and limit damage to cells and other body tissues. They also possess anti-inflammatory and anti-aging properties (Hollman *et al.*, 1999) [23]. Various studies have shown that there is a relation between certain polyphenols and their preventive effects on such diseases that can bring 'oxidative stress' such as cancers, cardiovascular disease, and neurodegenerative diseases. Their ability to improve the quality of blood vessels walls has also been shown in various experimental studies. Flavonoids have a supportive effect on the nervous system. In addition, they can control the action of certain enzymes and cell receptors. Studies suggest that flavonoids can also help regulate blood flow in the brain, which may result in better cognitive function.

Anthocyanins

These compounds are present in cell sap and are soluble in water. They are responsible for the red, purple, and blue colours of fruits, vegetables. Various *in vitro* studies have shown that anthocyanins and anthocyanidins stimulate insulin secretion and have protective effects on β -cells of pancreas. Even though anthocyanins are important antioxidants *in vitro*, their real biological activity is generally low because of their low stability and poor absorption. Various studies have shown health benefits of anthocyanins, which mainly focus on their positive effects on cardiovascular health, anti-cancer activity and anti-inflammatory properties. The consumption of anthocyanin-rich foods, particularly blueberries and apples or pears, was associated with a lower risk of type 2 diabetes in the study. In another study, diabetic patients who consumed pomegranate juice (384 mg/d anthocyanins) exhibited anti-oxidative effects such as a significant reduction in their serum lipid peroxides and the oxidative state of their monocytes/macrophages by 56% and 28%, respectively. (Ovando *et al.*, 2018) [36] reported that the main anthocyanin compounds are pelargonidin, cyanidin, and delphinidin. Cyanidin and its glycosides are natural dietary pigments which have been found with promising potential benefits to humans, especially in the prevention and treatment of diabetes mellitus.

Sulphur compounds

Our human body needs sulfur to build and fix your DNA and protect your cells from damage that can lead to serious diseases such as cancers. Sulfur also assists your body to metabolize food and contributes to the health of your skin, tendons, and ligaments. These sulphur compounds mainly present in cruciferous vegetables, are activators of liver detoxification enzymes. These chemicals are responsible for the pungent aroma and bitter flavor of cruciferous vegetables. They associated with benefits in cardiovascular health, bone health, blood sugar control, and detoxification. Vegetables uniquely contain the sulphur-containing phytochemicals glucosinolates, which can be hydrolyzed in the human gut to isothiocyanates (Singh *et al.*, 2012) [44]. The cruciferous vegetables are the richest sources of dietary isothiocyanates. Sulforaphane is a naturally occurring compound in cruciferous vegetables like broccoli, cabbage, and kale. Glucosinolates, progoitrin and sinigrin are found in white and red cabbage, Brussels sprout, and cauliflower. Allium vegetables are rich in organosulfur compounds Consumption of cruciferous vegetables offers a phytochemical strategy for providing protection against carcinogenesis, mutagenesis and other forms of toxicity of electrophiles and reactive forms of

oxygen.

Walnut

Walnuts are rich in omega-3 fats and contain higher amounts of antioxidants than most other foods. Eating walnuts may improve brain health and prevent heart disease and cancer. Walnuts are made up of 65% fat and about 15% of protein, they're low in carbs. They also contain a relatively high percentage of the healthy omega-3 fat alpha-linolenic acid (ALA) was studied by (Mayhew *et al.*, 2016) [32]. This makes up around 8–14% of the total fat content. Concerning walnuts, a recent meta-analysis of 24 RCTs of walnuts for outcomes on blood lipids uncovered a significant continuous dose response relationship between walnut-intake and blood cholesterol reduction.

West Indian cherry

It is one of the richest nutritional value fruit because of their high natural sources of ascorbic acid content of 1500–4500 mg/100g range and contains a plethora of phytonutrients like carotenoids phenolics, anthocyanins, and flavonoids. Vitamin-C is an incredible natural antioxidant. Warren, 2015 [50] have studied that Consumption of foods rich in vitamin-C helps the human body develop resistance against infectious agents and scavenge harmful, pro-inflammatory free radicals from the blood and thereby, help boost immunity, protect the body from cancers, aging, degenerative diseases, inflammation, and infections.

Kiwi fruit

Kiwi fruit is a highly nutritional fruit due to its high level of Vitamin C and its strong antioxidant including carotenoids, lutein, phenolics, flavonoids, and chlorophyll. Kiwi fruit is a rich source of fructose, galactose and minerals, its contains isoflavones and flavonoids which are important phytochemical in kiwi extract (Ferguson *et al.*, 2003). Phytoestrogen -- which has an important function as anti-carcinogenic, neuroprotective, and cardio protective activity. In ancient China, kiwi fruits were used for symptom relief of numerous disorders such as digestive problems, rheumatism, dyspepsia, and hemorrhoids, as well as a therapy for various cancers and also used to increase complete spontaneous bowel motion, improve transit time and rectal sensation.

Almonds

Almonds are among the world's most popular tree nuts and best sources of vitamin E. They are highly nutritious and rich in healthy fats, antioxidants, vitamins and minerals. It lower rates of heart disease, cancer and Alzheimer's disease. Study found that eating (42 grams) of almonds per day lowered LDL cholesterol by 5.3 mg/dL while maintaining "good" HDL cholesterol (Chen *et al.*, 2016).

Avocado

Avocado, has recently gained substantial popularity and is often marketed as a "superfood" because of its unique nutritional composition, antioxidant content, and biochemical profile. The oils of avocado are used to delight osteoarthritis and can be used as an alternate dietary supplement (Duester, 2001) [14]. Avocado and its oil acquire several salutary properties and hence they have been traditionally used for the treatment of different ailments and disorders. The β -sitosterol in avocados also has a special effect on immunity, contributing to the treatment of diseases such as cancer, HIV

and infections. 25% reduction in the risk of coronary heart disease with the consumption of 2g of such compounds per day. Phytochemicals as orhamnetin, luteolin, rutin, quercetin, and apigenin have been isolated from avocado leaves, which can help prevent the progress of various diseases related to oxidative stress. And avocado can be consumed in the form of processed products of avocado pulp include the paste, puree, and guacamole.

Moringa

Drumstick is regarded one of the best foods for not only building immunity but preventing and curing nearly 300 diseases. It can also be considered as a superfood. All parts of the plant are used to cure different types of ailments. It is a commercial crop and grown by farmers to reap high benefits due to its popularity in domestic and international market. It is also an eco-friendly crop which can be considered for sustainable farming.

Different parts of this plant are used for the treatment of different ailments in the indigenous system of medicine. The leaves are an excellent source of protein, UFAs (alpha linoleic acid), vitamins (especially Vitamin A, B, C and D) along with folic acid, pyridoxine and nicotinic acid, minerals (calcium, iron, zinc, potassium, etc), carotenoids, fibers, etc which is quite unusual as a vegetable (Das *et al.*, 2017) [12]. The different parts of this plant are used for the cure of arthritis and joints disorders, malnutrition, blindness, diabetes, high blood pressure, anemia, urinary tract problems, kidney stones, to induce lactation in nursing women and related ailments. Leaves of moringa also treat night blindness and improve memory. It acts as a good agent to improve immunity and is effective to combat against diseases affecting the immune system like AIDS, COVID 19, etc. Pods and seeds are rich in dietary fibers, carbohydrates, proteins, etc including UFA especially oleic acid. These serve as a good food fortification in dairy and fish feeds. Seed powder mixed with daily food is found to increase the protein content in our daily dietary intake

Mango

Mangoes are high in the antioxidants beta-carotene and vitamin C, which improves digestion, maintains eye health, boosts immunity, and anti-ageing properties. Mango is a good source of vitamin A, which encourages hair growth and the production of sebum — a liquid that helps moisturize your scalp to keep your hair healthy. (Rao *et al.*, 2007) [39] have studied that one cup (165 grams) of mango provides 10% of your daily vitamin A needs. Vitamin A is essential for a healthy immune system, as it helps fight infections. Mango polyphenols may fight oxidative stress, which is linked to colon, lung, prostate, breast and bone cancers.

Carrot

Carrot is a multi-nutritional food source. They play a major role in human nutrition, because of their high dietary value. They're rich in beta-carotene which helps keep your eyes healthy, protect your eyes from the sun and lowers your chances of cataracts and other eye problems. Yellow carrots have lutein -- Good for your eyes. Red carrots also have lycopene, which helps prevent heart disease. A deficiency in vitamin A can cause eye's photoreceptors to deteriorate, which leads to vision problems. β -carotene (the carotenoid with the most provitamin A activity) in carrots helps to protect vision, especially night vision and also provides

protection against macular degeneration and development of senile cataract, the leading cause of blindness in aged people (Anand Prakash *et al.*, 2018) [3]. Eating carrots rich in β -carotene may restore vision, lending truth to the old adage that carrots are good for your eyes. Carrots are one of the richest sources of provitamin A and a high intake of carotenoids linked with a significant decrease in post-menopausal breast cancer. Research has shown also that smokers who eat carrots more than once a week have a lower risk of lung cancer, while a β -carotene rich diet may also protect against prostate cancer.

Spinach

Spinach is one of the most important and nutritious vegetables eaten raw or cooked. It is also rich with iron; its use prevents from some of the diseases like osteoporosis, anemia results of iron deficiency. It is present in food in many forms such as raw, canned, boiled, pureed, frozen, dehydrated, cooked and baked. Spinach is excellent for the intestinal tract. Raw spinach juice, about one pint a day, will correct the most stubborn case of constipation (Gaikwad *et al.*, 2014) [17]. The spinach juice is effective in strengthening the gums and preventing and curing dental cavities. Infusion of fresh leaves of spinach prepared with two teaspoonfuls of fenugreek seeds mixed with honey is an effective expectorant tonic during the treatment of bronchitis, tuberculosis, asthma and dry cough due to congestion in the throat.

Kale

Kale is also good for heart health and helps to lower cholesterol, especially when steamed, Kale loaded with powerful antioxidants of quercetin and kaempferol (Daniel Alberto Jacobo-Velázquez, 2014) [11]. Vitamin K is an important nutrient that is involved in blood clotting, and also kale is high in lutein and zeaxanthin. Collectively, these nutrients provide your body with all kinds of support and protection, including prevention from osteoporosis, arthritis, and heart disease, and support for cell growth, a healthy metabolism, and detoxing your body of harmful toxins.

Phenolic acids in fruits and vegetable

Phenolic acids include derivatives of benzoic and cinnamic acid. They are beneficial to human health due to their potential antioxidants and avert the damage of cells resulted from free-radical oxidation reactions. Caffeic acid is the most abundant phenolic acid in several fruits such as berries. (0.33 mg/kg in Blueberry), protocatechic acid in raspberries, Paracoumaric acid is found in spinach, chlorogenic acid (11mg/100g), which is found in many fruits and in potatoes. Carrot has chlorogenic, caffeic, protocatechuic (29.5mg/100g), Broccoli contains sinapic, caffeic acid (15.0mg/100) and chlorogenic acid (3.5mg/100g) of found in tomato.

Celery

Celery is a good source of flavones. It has an alimentary herb as well as a special medicinal plant. Celery leaves are used for spicing up foods and drinks such as cocktails. It contains vitamins A, B1, B2, B6, C, E, K, P and minerals such as iron, calcium, phosphorus, magnesium and zinc. Vitamin C contained by celery strengthens the immunologic system and at the same time makes the body more resistant against new diseases (Jung *et al.*, 2014) [26]. The juice extracted from the petioles -- edema, rheumatic tendencies, gout, flatulence,

chronic pulmonary catarrh, tendencies toward overweight and lack of appetite. It is a strong diuretic, and is used as a urinary antiseptic, mainly because of the -- volatile oil Apiol. Celery can be helpful in treating skin problems, when it is used raw, or prepared as tea. Celery seed decoction is used for bronchitis, rheumatism, and as a sedative and Oil extracted from the root can restore sexual potency affected by illness.

Onion

Onions are rich in Quercetin, it Provide various beneficial properties for human health as a anti-oxidant, anti-inflammatory agent, antiviral activity, cardiovascular properties and anticancer properties. Onions may lower the risk of cancer of the brain, esophagus, lung and stomach. The fruit and vegetable consumption was reported to contribute to an average of 15 mg to 40 mg of quercetin per day from the diet (Gulsen *et al.*, 2007). The quercetin and Kaempferol will help to decrease cancer tumor initiation, Promote healing of stomach ulcers, Inhibit the proliferation of cultured ovarian, breast and colon cancer cells.

Orange juice

Orange juice is a source of the flavanone glycoside hesperidin. The sweet orange is one of most economically important fruits in worldwide. Oranges in their whole and juiced form are predominant sources of antioxidants in the diet, and multiple studies have shown that the body absorbs the antioxidants better in its juice form. (Rampersaud, 2007) [38] studied that moreover, a long-term study (twelve months) showed that consumption of orange juice (480 mL daily) triggered reductions of 11% in total cholesterol, 18% in LDL-cholesterol, 12% in Apo lipoprotein B, and 12% in the LDL/HDL ratio in comparison to non-consumers.

Grapes

Grape is one of the ancient crops linked with human history during the evolutionary development of men. The flavanols catechin and epicatechin are common in grapes. Epidemiological studies demonstrated the moderate amount of red wine made from grape juice intake has the beneficial effect of on the neurodegenerative process. Resveratrol is naturally occurring in grapevines where it is almost exclusively synthesized in berry skins, but in muscadine grapes it is found also in seeds (Marambaud *et al.*, 2015) [31]. The content of this substance in red grapes is higher than in white ones. Total resveratrol content in 100 g red grape varies between 0.15 mg and 0.78 mg. It is estimated that fresh grape skins contain between 50 and 100 µg resveratrol per gram wet weight. Resveratrol shows its potentiality in cardioprotectivity, curing neurological disorder, Alzheimer's disease, Parkinson's disease and Huntington's disease, longevity, and anti-ageing properties. Substance in grape is "Melatonin," which is considered for one of the most powerful antioxidants involved in various physiological functions in the human body.

Blueberries

The dark blue-purple color is due to the high concentration of anthocyanins, that are phytochemicals with strong antioxidant action, It has been shown that consumption of 120 ml of blueberry juice leads to higher levels of anthocyanins in the blood compared to red and white (2.42 mmol, 2.04 mmol and 0.47 mmol, respectively), indicating the high bioavailability of their anthocyanins (Pojer *et al.*, 2013) [37]. The contribution

of blueberries in cerebral function seems to be associated with a reduction in the risk of declaring Alzheimer's disease and other neurodegenerative diseases by reducing symptoms such as loss of balance and coordination and prevention of memory loss.

Studies have shown that a quantity of 150 g of blueberries per week may contribute to reduction in blood pressure levels, and a number of other studies have shown a potential effect on the prevention of various types of cancer such as colon cancer, due to the presence of phenolic compounds, tannins, flavones and generally antioxidant ingredients. Specific studies have shown a potential inhibitory effect of flavonoids kaempferol and luteolin in the development of ovarian cancer.

Pomegranate

Pomegranate is considered a popular edible fruit, while in recent years a lot of scientific studies show potential beneficial effects of the pomegranate on health promotion and advocacy from various pathologies situations, hence scientists consider it as superfood. The important properties of the pomegranate are directly related to its high content of bioactive substances, including phenolic compounds, polyphenols, ellagitannins and vitamins. Many of these phytochemicals have been shown to have significant antioxidant and anti-inflammatory properties which promote human health. The most important pomegranate polyphenol is punicalagin which is responsible for over 50% of the strong antioxidant activity of the juice (Sumner *et al.*, 2005) [46]. Studies have concluded that pomegranate juice consumption can be beneficial to high-risk populations of atherosclerotic and cardiovascular diseases, as well as people with high risk factor for diabetes.

Cranberry

Cranberries are an excellent source of antioxidant ingredients, especially phenolic compounds and in particular they contain high concentrations of proanthocyanidins, flavonoids such as flavonols, quercetin and myricetin, ellagic acid and chlorogenic acid (Ruel *et al.*, 2006) [40]. Hence they have the potential to provide strong protection against free radicals. The consumption of cranberry juice decreases LDL and increases HDL Cholesterol. Also decreased the overall incidence of urinary tract infection (Wang *et al.*, 2012) [48].

Acai berry

The acai berries are rich in ω -3 fatty acids, amino acids, proteins, electrolytes, metals, fibers, sterols, vitamins A, B1, C and E, iron, calcium, copper, magnesium, potassium and zinc. They contain in high amounts anthocyanins, which give them important antioxidant properties. They also provide to the human body fatty acids such as ω -3 and ω -9, which improve the lipidemic profile and exert anti-inflammatory action (Crozier *et al.*, 2011) [10]. Additionally, it appears that help human body by excretion of harmful toxins. The high content of acai berry in antioxidants was proven along with its multiple benefits for health. With the participation of 12 healthy volunteers, improvements to metabolic levels and protection against cancer cells where proven.

Goji berry

Goji berries are one of the richest natural sources of nutrients, such as β -carotene, vitamins C, E, B1 and B2, minerals, antioxidants and amino acids, consumption of goji berries has been associated with the enhancement of the endogenous

antioxidant system, through increased production of enzymes such as superoxide dismutase, resulting in reduction of LDL oxidation. (Amagase *et al.*, 2009) [2] reported goji berries can reduce inflammation, reduce blocking of the blood vessels, while they can contribute through the antioxidants contained in the prevention of various types of cancer. Goji contribute to improved vision due to its high content of antioxidants, including compounds such as zeaxanthin, lutein, polysaccharides and polyphenolic compounds. Beta-sitosterol of Goji berries seem to significantly inhibit stomach cancer, suppressing the reproduction of cells and toxicity production of cancer cells.

Broccoli

Broccoli is an edible green plant. They are rich in vitamin C, dietary fiber and also contain glucoraphin, sulforaphane, selenium and isothiocyanates - may help lower your blood sugar and might stop cancer cells from forming in your body.

Cruciferous vegetables such as broccoli may play a role in “green chemoprevention,” in which people use either the whole plant or extracts from it to help prevent cancer (Conaway *et al.*, 2000) [8]. Studies have shown that vitamin C may play a role in preventing or treating skin conditions such as shingles and skin cancer, Broccoli may have anti-inflammatory effects, Scientists found that the antioxidant effect of sulforaphane in broccoli helped reduce inflammation markers in laboratory tests. They therefore concluded that the nutrients in broccoli could help fight inflammation.

Extraction methods for bioactive compounds

There are various techniques for the extraction of bioactive compounds from fruit and vegetable wastes depending on their source, chemical properties, functionality, and end-use. They are widely studied for the prevention of multiple diseases such as cancer, inflammatory, cardiovascular and neurodegenerative diseases.

Table 2: Utilization of bioactive components in human diet

Bioactive components	Sources	Extraction methods
Epigallocatechin 3 (flavonoids/catechins)	Apples, grapes, berries, red wine,	Maceration, ultrasonic extraction, microwave extraction, stirring
Apigenin	grapefruit, oranges, onions	Organic solvent extraction using methanol, ethanol and propanol.
Quercetin (flavonoids/flavonols)	Onions, broccoli, berries	Subcritical water extraction, ultrasonic-assisted extraction
Naringin (flavonoids/flavanones)	Citrus fruits, tomatoes	Supercritical fluid extraction, conventional soxhlet extraction with different volatile solvents
Hesperetin (flavonoids/flavanones)	Citrus fruits, tomatoes,	Microwave-assisted extraction, extraction with organic solvents and mixtures (DMSO methanol)
Isoliquiritigenin (flavonoids/chalcones)	bean sprouts	Soxhlet extraction, supercritical fluid extraction
Gallicacid	Berries, pineapples, bananas, Wines	Soxhlet extraction, ultrasonic-assisted extraction, microwave-assisted extraction
Ellagic acid	Berries, pomegranate, walnuts	Ultrasound-assisted extraction
Resveratrol (stilbenes)	Red wine, grapes, berries	Supercritical fluid extraction, pressurized liquid extraction (water, methanol and othe organic solvents)
Lycopene, β carotene, Xanthophylls and Lutein	Tomatoes and its by-products Spinach, kale, Mangos and carrot	supercritical fluid extraction (Ethanol solvent)

Encapsulation of bioactive components

The functional food industry is increasingly aiming to add bioactive components to food, particularly those foods that are consumed as part of the normal diet. Food bioactives are physiologically active components of plant origin which have a role in health beyond basic nutrition. Consumers are becoming more aware of their health and well-being and the important role that healthy eating can potentially play in improving a range of health conditions. These include weight control, diabetes, cardiovascular health, digestive health, joint health, cognitive function, immune function and anti-ageing. Energy foods and beverages are also of increasing interest for sports nutrition. The food industry is interested in incorporating bioactive ingredients in their products. These ingredients need to be protected from degradation and undesirable interactions with food components, and cannot usually be added directly to food without compromising food quality. Nano- and micro-encapsulation offer solutions to these problems.

The main purpose of encapsulation is to produce particles that control mass transport behavior. The shell material prevents

diffusion of the material from the microcapsule or into it. The wall material (encapsulant) protects the sensitive bioactive agent (core) from the environment (such as oxygen, water and light) until it is released at a desired time /site. When the encapsulated bioactive is intended for incorporation into foods, the materials used for encapsulation of food bioactives need to be food grade. Hence encapsulating materials commonly used include proteins, polysaccharides lipids and allowed food additives. The methods used for encapsulation include both physical and chemical processes (Zuidam *et al.*, 2010).

Table 3: Processes used for encapsulation

Physical	Chemical
Spray drying (of emulsions)	Simple coacervation
Spray chilling	Complex coacervation
Coating – fluidised bed, spinning disk	Solvent evaporation
Extrusion – centrifugal, pressure	Liposomes
Gelation	Chemical adsorbents
Emulsion formation	Inclusion complexation

Table 4: Application of microencapsulated bioactive ingredients in food industry

Type of Encapsulated Food Ingredients	Examples Purpose
Lipids: Fish oil, linolenic acid, rice bran oil, sardine oil, palmitic acid,	To prevent oxidative degradation during processing and storage
Flavoring agents: Citrus oil, mint oils, onion oils, garlic oils, spice	To transform liquid flavorings into stable and free flowing powders which are easier to handle
Vitamins: Fat soluble: vitamin A, D, E and K. Water soluble: Vitamin C, vitamin B1, vitamin B2, vitamin B6, vitamin B12, niacin, folic acid	Reduce off-flavors, permit time-release of nutrients, enhance the stability to extremes in temperature and moisture, reduce each nutrient interaction other ingredients
Acidulants: Lactic acid, glucono-g-lactone, Vitamin C, acetic acid, potassium sorbate, sorbic acid, calcium propionate, and sodium chloride	Used to assist in the development of color and flavor. Baking industry uses stable acids and baking soda in wet and dry mixes to control the release of carbon dioxide during processing and subsequent baking.
Colorants: Annato, β -carotene, turmeric	Encapsulated colors are easier to handle and offer improved solubility, stability to oxidation, and control over stratification from dry blends

Bioactive components in Food fortification

Fruits and vegetables constitute together with other groups of food should be promoted as favorable in all periods of life. The health benefits of fruits and vegetables and evidences indicating that people has showing more interest on consumption of whole foods than dietary supplements, there is a need to develop several approaches to retain the active principles in fruits and vegetables as well promote various food technologies incorporating them. A number of food based approaches are currently in practice to address the nutritional deficiencies. One such approach is Food-to-Food fortification.

In food fortification technology, chemical or extracted forms of nutrients have been adding to the vehicles to recover the loss of nutrients whereas, in Food to Food Fortification, select food combinations are using to enhance the bio availability of nutrients (Parveen Begum *et al.*, 2015) ^[41]. It can apply at home level also. This process empowers households to take ultimate responsibility over the quality of their diet through own production of nutrient rich foods. Products fortified with nutrients represent a segment of food with a health-promoting character, but available in many branches of the food industry. Breakfast cereals with the addition of vitamins, fruit juices with vitamin C or milk desserts with calcium are commonly available in retail. Fruit juices and drinks were fortified exclusively with such vitamins as: C, B1, B2, B6, B12, A, E, folic acid, pantothenic acid, and niacin, and with minerals: magnesium. Vitamin C addition was visible in the list of fortifying components in all analyzed juices and non-alcoholic drinks. Groups of fortified foods most frequently indicated by the respondents included: fruit juices and drinks, dairy products. The choice of fortified food products by respondents was mainly driven by their health-promoting properties.

Bioactive components in Food supplements

Food supplements are concentrated sources of bioactive compounds (i.e., minerals, amino acids, vitamins, phenolic compounds etc.) to supplement the normal diet by increasing the total intake of these substances, but they are not intended to treat disease. Food supplements are used by the population for many different purposes including health maintenance, preventing diseases, balancing diets, improving appearance and wellness as well as to increase sport performance. Incorporating functional foods into the diet can be easily achieved with a little thought and planning, and does not have to be expensive. Including an abundance of plant foods as well as healthy protein and dairy foods in your diet is a sure way to increase your intake of functional foods. Phytochemicals are specific type of bioactive compounds that

are found in plant foods such as fruits, vegetables, nuts, and whole grains, so by consuming more of these foods on a regular basis, will help to increase consumption of health promoting phytochemicals. However, white and colorless foods such as garlic and onions are rich in health-promoting phytochemicals. By consuming many different colors of plant foods, the more likely it is that you will consume a larger variety of phytochemicals. The most benefits will come from eating a variety of foods, as they will provide a variety of essential nutrients and bioactive compounds. Reducing intake of highly processed foods will leave room in the diet for more whole, nourishing foods. Balance is the key to enjoying eating, while at the same time providing the body with the nutrients it needs to stay healthy and reduce the risk for disease.

Role of Bioactive components in human diet

Bioactive compounds are defined as components of food that have an impact on physiological or cellular activities in the humans or animals that consume such compounds. Various bioactive compounds have unique effects on different chronic diseases such as cancers, diabetes mellitus, CVD, certain neurological conditions etc. Certainly, one of the easiest ways to prevent and control the risk of cancer is to consume enough fruits and vegetables which are high in biological activity. Several studies have shown that there is positive relation between consumption of carotenoids-rich fruits and vegetables and decreased risk of cancer, particularly lung cancer, prostate cancer, breast cancer, and head and neck cancers, and the incidence of esophageal, colon, and other gut cancers, as well as an inverse relation between serum concentration of carotene and such cancer risk.

Conclusion

Superfoods are foods that are considered to be extremely healthy and sometimes even the cure for bodily issues such as constipation, diarrhoea, irritable bowel syndrome, fatigue or headaches and also they prevent from some chronic diseases. Nowadays increasing dietary diversity by providing foods with adequate amounts of micronutrients is one of the most effective ways to sustainably prevent hidden hunger and malnutrition. Hence it is important to fulfil the micronutrients' need through nutrient-dense complementary foods. For this, ensuring intake of a diverse diet with a balanced and adequate combination of macronutrients (carbohydrates, fats, and protein), essential micronutrients and other food-based substances such as natural antioxidants, phenolic compounds, carotenoids and sulphur compounds, so the continuous spread of superfoods is a fact due to tendency to find a new ways of shielding health, due to intense rhythms life of modern reality,

Hence, the individuals should be advised to take sufficient nutritious diets, including more amounts of various fruits and vegetables. It has been suggested that persons wishing to reduce their risk of cancer must eat several pieces of fruits and several portions of vegetables every day. Consumption of various fruits and vegetables play a significant role against malnutrition cancer and hidden hunger.

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