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## Antioxidant properties of fruits and vegetables

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### Abstract

The present day stress and pollution leads to the production of electronically unbalanced atom and molecules called free radicals in our body. These free radicals can cause damage to body cell and lead to diseases. The body does have antioxidants against these rogue "oxidant" compounds. When there are too few antioxidants to counteract free radicals, significant damage can occur, leading to a variety of chronic degenerative diseases such as, heart disease, cancer, metabolic disorders etc. Fruits and vegetables are generally taken as sources of water soluble vitamins, minerals, fiber and phytochemicals. These compounds of fruits and vegetables may help to keep healthy and reduce the incidence of chronic degenerative diseases.

**Keywords:** Fruits, vegetables, antioxidant, free radicals, oxidative stress

### 1. Introduction

Better health and nutrition is fundamental importance for human being and we obtain better health and nutrition through chemicals found in food. Food is a mixture of chemicals, some of which are very crucial for normal body functions. These essential chemicals are called nutrients. We need nutrients for normal body growth and development, for maintaining cells and tissues, for fuel to do physical and metabolic processes (Charanjit, 2007) <sup>[1]</sup>. Currently, among these nutrients, more attention is given to the micronutrients. Compared with other nutrients micronutrients required in small amounts, therefore, they are called micronutrients. These include dietary fiber, vitamins, minerals, enzymes and phytochemicals. These micronutrients are abundantly found in fresh fruits and vegetables. Fruits can be defined as "infructescences or the fleshy portions of floral organs that have achieved an appropriate degree of maturity and are fit for human consumption", whereas, vegetables can be defined as "any cultivated herbaceous plant in season that can be used for food, whether raw or in cooked form" (Codigo and Alimentario) <sup>[2]</sup>.

Fruits and vegetables play a significant role in human nutrition, especially as sources of vitamins such as ascorbic acid, vitamin-A, thiamine (B<sub>1</sub>), niacin (B<sub>3</sub>), pyridoxine (B<sub>6</sub>), folacin (also known as folic acid or folate), vitamin- E, minerals, dietary fiber and non nutritive compounds known as phytochemicals (Craig and Beck, 1999) <sup>[3]</sup>. These nutrients and non nutritive compound of fruits and vegetables are involved in many chemical reactions which take place constantly in our body including digestion and absorption mechanism. Apart from these basic functions, some of these compounds also act as an antioxidant in our body and reducing the risk of many chronic diseases including cardiovascular, cancer, and diabetes, and neurological degeneration (Block, *et al.*, 1992) <sup>[4]</sup>. Due to the development in science and medical field, noticeable progresses have been achieved in providing advance health care. However, there are huge numbers of people who prefer herbal supplements rather than consuming medicine. In fruits and vegetables, numbers of nutraceutical elements are there which possesses medicinal properties. Therefore, it is recommended that every individual should consume fruits and vegetables on regular basis to avoid the occurrence of diseases and to acquire healthy life.

### Nutritional importance of fruits and vegetables

Water content of fresh vegetables is around 75-95% and they are low in calorie (20-40 Kcal per 100gm). They have very low content of protein i.e 1-6% and fat i.e. 0.5 -0.6%. Vegetables provide variable amount of carbohydrates (3-20%), especially simple carbohydrates which can

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make up 1-6% (Russolillo and Martinez, 2001) [5]. Water accounts for 80 – 90% of the weight of the fruits. Up to 10% of fruits is made up of simple sugars, except banana and grape (15 – 20%), which are very sweet and contain more calories (Belitz, 1997) [6]. Nutritional value of fruits and vegetables are in their micronutrient such as vitamin –C, B complex vitamins, potassium, magnesium, fiber and non nutritional bioactive compounds. Many fruits and vegetables contain coloring matter called pigments, which are natural coloring agents and have strong antioxidant potential.

### Health benefits of fruits and vegetables

Epidemiological studies have shown that consumption of fruits and vegetables are associated with improvement in human health. Fruits and vegetables in the daily diet have been strongly coupled with reduced risk for some forms of cancer, heart disease, stroke, and other chronic diseases (Goldberg, 2003; Prior and Cao, 2000; Anonymous, 1999; Quebedeaux and Bliss, 1988; Quebedeaux and Eisa, 1990; Southon, 2000; Barberan and Espin, 2001; Wargovich 2000) [7-14]. Some components of fruits and vegetables (phytochemicals) are strong antioxidants and function to modify the metabolic activation and detoxification of carcinogenic compounds, or even influence processes that alter the course of the tumor cell (Wargovich, 2000) [14]. Though, the capacity of antioxidant varies greatly among fruits and vegetables (Prior and Cao, 2000; Perkins-Veazie

and Collins, 2001; Kalt, 2002) [8, 15, 16], it is better to consume a variety of commodities rather than consuming a few with the highest antioxidant capacity.

There is increasing evidence that consumption of whole foods is better than isolated food components such as dietary supplements and nutraceutical products. A study (Southon, 2000) [12] have revealed that, increased consumption of carotenoid-rich fruits and vegetables was more effective than carotenoid dietary supplements in increasing LDL oxidation resistance, lowering DNA damage, and higher repair activity in human volunteers who participated in a study conducted in France, Italy, Netherlands, and Spain. In another study, antioxidants (vitamins A, C and E) were added as a dietary supplements into the diet of cancer treatment patients, who were eating a balanced diet of fruits and vegetables, negatively impact was found on their radio- and chemotherapies (Seifried *et al.*, 2003) [17]. High consumption of tomatoes and tomato products has been linked to reduced carcinogenesis, particularly prostate cancer, and has been thought to be due to the presence of lycopene, which gives red color to tomatoes (Giovannucci, 2002) [18]. However, use of tomato powder effectively reduced prostate carcinogenesis in rats, while lycopene supplements, considered the primary active ingredient of tomatoes, had no effect (Boileau *et al.*, 2003) [19]. All these comparative studies have shown that consumption of whole fresh fruits and vegetables are more beneficial than supplements made up with the same.

**Table 1:** Nutritive compounds of fruits and vegetables, its impact on human health

Constituent	Sources	Effects on human health
Vitamin C (ascorbic acid)	broccoli, cabbage, cantaloupe, citrus fruits, guava, kiwifruit, leafy greens, pepper, pineapple, potato, strawberry, tomato, watermelon	prevents scurvy, aids wound healing, healthy immune- system, cardiovascular-disease
Vitamin A (carotenoids)	dark-green vegetables (such as collards, spinach, and turnip greens), orange vegetables (such as carrots, pumpkin, and sweet potato), orange-flesh fruits (such as apricot, cantaloupe, mango, nectarine, orange, papaya, peach, persimmon, and pineapple), tomato	night blindness prevention, chronic fatigue, psoriasis, heart disease, stroke, cataracts
Vitamin K	nuts, lentils, green onions, crucifers (cabbage, broccoli, brussel sprouts), leafy greens	synthesis of pro-coagulant factors, osteoporosis
Vitamin E (tocopherols)	nuts (such as almonds, cashew nuts, filberts, macadamias, pecans, pistachios, peanuts, and walnuts), corn, dry beans, lentils and chickpeas, dark-green leafy vegetables	heart-disease, LDL-oxidation, immune-system, diabetes, cancer
Fiber	most fresh fruits and vegetables, nuts, cooked dry beans and peas	diabetes, heart disease
Folate (folicin or folic acid)	dark-green leafy vegetables (such as spinach, mustard greens, butterhead lettuce, broccoli, brussels sprouts, and okra), legumes (cooked dry beans, lentils, chickpeas and green peas), asparagus	birth defects, cancer heart disease, nervous system
Calcium	cooked vegetables (such as beans, greens, okra and tomatoes) peas, papaya, raisins, orange, almonds, snap beans, pumpkin, cauliflower, rutabaga	osteoporosis, muscular/ skeletal, teeth, blood pressure
Magnesium	spinach, lentils, okra, potato, banana, nuts, corn, cashews	osteoporosis, nervous system, teeth, immune system
Potassium	baked potato or sweet potato, banana & plantain, cooked dry beans, cooked greens, dried fruits orange.	hypertension (blood pressure) stroke arteriosclerosis

(Source: Mbata, Internet journal of food safety<sup>[20]</sup>)

### Oxidative stress and its harmful effect

In human body certain molecules called reactive oxygen species (ROS) and reactive nitrogen species (RNS) are normally produced as a result of defense mechanism and as the by-products of cellular metabolic processes which utilizing oxygen. These reactive species include free radicals or certain molecules which may be oxidizing agent or convertible to free radicals. Many factors are associated with the production of free radicals in the body; these include smoking, drinking, alcohol, too much fat in the diet, too much sun exposure, too many pollutants in the air and even too much exercise and stress. Free-radical mechanisms have been implicated in the pathology of several human diseases,

including cancer, atherosclerosis, malaria, and rheumatoid arthritis and neurodegenerative diseases. For instance, the superoxide radical ( $O_2^{\cdot-}$ ) and hydrogen peroxide ( $H_2O_2$ ) are known to be generated in the brain and nervous system *in vivo*, and several areas of the human brain are rich in iron, which appears to be easily mobilizable in a form that can stimulate free-radical reactions. When these free radicals produced in excess, can cause tissue injury. However, tissue injury can itself cause ROS generation (e.g., by causing activation of phagocytes or releasing transition metal ions from damaged cells), which may (or may not, depending on the situation) contribute to a worsening of the injury (Okezie, 1998) [21].

### Natural defense of fruits and vegetables against oxidative stress

Antioxidants refer to any substance that delays or inhibits oxidative damage to a target molecule. Lipids, proteins, nucleic acids, and carbohydrates are potential targets of oxidative damage. Antioxidants protect the target sample by scavenging oxygen-derived species, minimizing the formation of oxygen-derived species, binding metal ions, replacing damage to the target, and destroying badly damaged target molecules and replacing them with new ones. Antioxidants are largely found in plant foods chiefly in fruits and

vegetable. These molecules neutralize the free radicals by donating an electron and reduces incidence of chronic degenerative diseases and health risk related to the aging. Free radicals contain lots of energy and are reactive, unstable molecules. They contain only one electron in their outermost shell and need a second one to become stable (Halliwell and Gutteridge, 1995) [22], which is provided by antioxidant. These free radicals may oxidize nucleic acids, proteins, lipids and DNA and can initiate degenerative disease. In table 2 some plant compounds are mentioned, which have positive health effect.

**Table 2:** Non-nutritive plant constituents that may be beneficial to human health

Constituent	Compound	Plant Sources	Effects on human-wellness
<b>Phenolic compounds</b>			
Proanthocyanins	Tannins	apple, grape, cranberry, pomegranate	cancer
Anthocyanidins	Cyanidin, malvidin, delphinidin, pelargonidin, peonidin, petunidin	red, blue, and purple fruits (such as apple, blackberry, blueberry, cranberry, grape, nectarine, peach, plum & prune, pomegranate, raspberry, and strawberry)	heart disease, cancer initiation, diabetes, blood pressure, allergies
Flavan-3-ols	Epicatechin, epigallocatechin catechin, gallic acid	apples, apricots, blackberries, plums, raspberries, strawberries	platelet aggregation, cancer,
Flavanones	Hesperetin, naringenin, eriodictyol	citrus (oranges, grapefruit, lemons, limes, tangerine)	cancer
Flavones	Luteolin, apigenin	celeriac, celery, peppers, rutabaga, spinach, parsley, artichoke, guava, pepper	cancer, allergies, heart disease
Flavonols	Quercetin, kaempferol, myricetin, rutin	onions, snap beans, broccoli, cranberry, kale, peppers, lettuce	heart disease, cancer initiation, capillary protectant
Phenolic acids	Caffeic acid, chlorogenic acid, coumaric acid, ellagic acid	blackberry, raspberry, strawberry, apple, peach, plum, cherry	cancer, cholesterol
Xanthophylls	Lutein, zeaxanthin, $\beta$ -cryptoxanthin	sweet corn, spinach, corn, okra, cantaloupe, summer squash, turnip greens	macular degeneration
Monoterpenes	Limonene	citrus (grapefruit, tangerine)	cancer
<u>Sulfur compounds</u>	Glucosinolates, isothiocyanates, indoles, allicin, diallyl isulphide	broccoli, Brussels sprouts, mustard greens, horseradish, garlic, onions	cancer, cholesterol, blood pressure, diabetes
Lycopene	tomato, watermelon, papaya, Brazilian guava, Autumn olive, red grapefruit		cancer, heart disease, male infertility
$\alpha$ -carotene	sweet potatoes, apricots, pumpkin, cantaloupe, green beans, lima beans, broccoli, brussel sprouts, cabbage, kale, kiwifruit, lettuce, peas, spinach, prunes, peaches, mango, papaya, squash and carrots		tumor growth
$\beta$ -carotene	cantaloupes, carrots, apricots, broccoli, leafy greens (lettuce, swiss chard), mango, persimmon, red pepper, spinach, sweet potato		cancer

(Source: Mbata, Internet journal of food safety [20])

### Importance of antioxidants

Antioxidants are of interest to food industry since; they prevent rancidity in food caused by oxidation of fat. Some antioxidant agents are usually added while preserving the food. These agents prevent the oxidation in food and rendering it in a fit condition for human consumption. Antioxidants are also of the interest to clinicians as they may help to protect the human body against damage by Reactive Oxygen Species (ROS). It has been shown that free radicals including reactive oxygen species like superoxide ( $O_2^-$ ), hydrogen peroxide ( $H_2O_2$ ) and hydroxyl radical ( $OH^\bullet$ ) are known to be generated in many organs (brain and liver) as a product of normal metabolism and by radiation internally, they are formed during  $O_2$  metabolism and lipid peroxidation. The purpose of antioxidant in physiological setting is to prevent ROS concentration from reaching a high level within a cell that may cause damage (Imlay, 2003) [23].

### Internal and external sources of antioxidants

Cellular structure of human body itself provides natural defense against oxidative stress. Cellular antioxidant may be

enzymatic (glutathione, catalase, super oxide dismutase) or non-enzymatic (thiols, vitamins, minerals, metals, phytochemicals).

There are two types of antioxidant defense systems in the human body i.e. enzymic and non-enzymatic.

**(a) Enzymatic:** Super-oxide dismutase, glutathione peroxidase, catalase and Glutathione transferase are the enzymes involved in neutralizing the free radicals produced in the body (Schafer *et al.*, 2001) [24].

**(b) Non-enzymatic:**  $\alpha$ -tocopherol, vitamin C,  $\beta$ -carotene, selenium, phenolic compounds etc. are compounds involved in free radicals neutralizing reaction.

Among these all vitamin C,  $\beta$ -carotene, tocopherol, selenium and phenolic compounds such as Flavonoids, Anthocyanins, Condensed tannins, Lignans, cinnamic acids etc are of diet origin (Miller *et al.*, 1995) [25].

Antioxidants may act at different levels in the oxidative process e.g. by scavenging initiating radicals, binding metal ions, scavenging peroxy radicals or by removing oxidatively

damaged bio-molecules and other types of action (Valko *et al.*, 2005) [26].

### Conclusion

In modern word of science and technology, human being have achieved control on all most every aspect of life but still health is a prime focus. Consumption of nutritious foods is a only way to reach good health. Basic foods like cereals and pulses are also extensive sources of macronutrients. They also contain many micronutrients but if we compare it with fresh fruits and vegetables, the amount is much higher in fruits and vegetables. If these foods consumed on regular basis, may provide positive health effects.

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