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**Review article**

**NUTRITIONAL COMPOSITION AND HEALTH BENEFITS OF POTATO: A REVIEW**

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**Abstract**

*Solanum tuberosum* is the botanical name of the potato. Globally, the consumption of potatoes is increasing with time because of composed wide nutrients range. The flesh of potato is a rich source of antioxidants, vitamin C, B1, B2, B6, B9 and numbers of trace elements, which is a necessary part of the diet and plays a functional role to maintain the human body. Ascorbic acid and potato colorant, carotenoids including lutein, zexanthin, and violaxanthin act as antioxidants that aid to improve the oxidative stress in human cells. Chlorogenic acid and anthocyanins are phenolic compounds present in potato skin in the form of phenolic acids. Both antioxidants and phenolic compounds have ability to suppress cancer cells and improve heart health by lower the risk of B.P and hypertension. The current review has been conducted on the nutritional composition and health benefits of potato.

**Introduction**

The botanical name of the potato is *Solanum tuberosum* which is related to large group Solanaceae and the genera of this family are called *Solanum*. Both tropical and subtropical environments are suitable for the growth of the potato. [1] The importance of potatoes in various countries because of them contains a wide range of vital nutrients such as low fatty contents, minerals and vitamins. It is a higher source of ascorbic acid, vitamin B6, vitamin B9, vitamin B1 and both macrominerals and microminerals (including potassium, iron, copper, manganese, phosphorus). The nutritional valuability of potato is rich due to the composition of dietary constituents like fiber, CHO (e.g. starch), quality protein, vitamins and minerals. Moreover, potato is considered as major food crops after maize, rice and wheat. [2]

Both red and purple potatoes are contain anthocyanins, these pigments are present in potatoes flesh. [3] Having a link with health promotion, in the form of red and purple color, the anthocyanins are naturally source by fleshy potatoes. [4] Instead of this, potato tubers also contain some quantities of phytonutrients like phenolic compounds, flavonoids and carotenoids which is reduced the risk of heart diseases [5] and is also act as an anti-inflammatory, antioxidant, cytotoxic and anti-tumor. [6] As compared to the other more largely consuming vegetables, the unique one is potato. In products like fresh fries, almost 60% of potato is used at the industrial level. For home preparations and fresh food service applications, the remaining 40% of potatoes are used. [7] Chips and shoestring are important products of potatoes (12%), frozen French fries (30%), dehydrated items (12%), table stocks (31%) and other uses (15%). [8] Globally, daily, more than 1 billion people consume potatoes. [9],[10]

Worldwide, the demand for fresh-cut potatoes is increasing as the living standards of people is rising. Like many other fruits and vegetables, fresh-cut potatoes are also prone to browning. [11],[12] The

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deterioration process like softening of tissues, water loss and off-flavor production may accelerate, when the tissues suffer from wounding stress caused by the cutting process, hence it limits the production of ethylene and shelf-life of fresh-cut potatoes. [13],[14]

According to this study dry matter and starch were secluded that the chemical composition having total starch, free glucose, dietary fibers and protein amount in potato by dry matter, and apparent amylose and total phosphorus amount in potato starch were examined. The survey results indicated that different functional properties of potato dry matter and starch of individual cultivars are due to differences in chemical composition and molecular chain length of potato starch. [15] Various starch granular size, phosphorus amount and amylose amount could be primary function impacting starch functional properties. [16]

Potatoes, in industrial and developing countries, are used as CHO food. Due to wrong information about the rich glycemic index (GI) in potato food, this field is decreased eating levels during past years. Some factors e.g. varieties, starch shape, raping level, processing procedure are played a vital character in the glycemic index of potatoes. [17] Various cooking techniques, skin remove techniques, cutting into pieces does not affect the glycemic index, but cooling as well as cold storage are decreased approximately 25% GLs level of potatoes due to reheating. [18]

The conducted study was examined the potato containing nutrient and bioactive substances and their impact on humans health. In global, *Solanum tuberosum* is consumed just like rice and wheat which is considered a nutrient food for humans. Potatoes are cultivated in about 160 countries in the world. Processed potatoes Consumption level is increasing as compared to fresh. Globally, the population is increasing day by day, the consumption of potatoes have also increased because of its nutritional composition impacts on human health. The potatoes vegetable is the source of rich-carbohydrates (in the form of starch), high caloric contents and a small amount of fat. In potato, protein is present in very low quantity but has a very good biological level of nineteen to a hundred. It is also a good source of vitamins (e.g. ascorbic acid and B group) and minerals especially potassium. Fiber content is present in a potato skin. Several other bioactive compounds are present that act as an antioxidant. [19]

### **Nutritional Composition/Chemical**

Globally, potatoes are considered as number 4th, according to grow crop rank, in which the first three are wheat, rice and corn, these three belong to cereal family but potato belongs to the tuber group. The number 4th growing crop is an excellent source of nutrients e.g. protein, fat, carb, minerals, vitamins, phenolic compounds, antioxidants, and fibers. According to the recommended daily allowance (RDA vitamins or minerals present in potatoes is more than caloric vale. Ascorbic acid is present in potato, the study showed that, with the reference of USDA databases, 173 g of red potatoes provide thirty-six percent of RDA. [20]

The one hundred grams of potato provides ninety kilocalories energy-containing vital components such as 75.0 g water, 19 g carbohydrates, 0.1 g fat, 19 g CHO, 0.25 mg ascorbic acid, 0.03mg B2, 12mg calcium, 0.25mg Pyridoxine, 1.1mg B9, 0.08mg B1, 1.8mg iron, 57.0 mg phosphorus, 23mg magnesium and 6mg sodium. *Solanum tuberosum* vegetable is composed of 4 to six vitamins which are required to maintain the body nutrition, and these can take every day from crops. Ascorbic acid, B1, B2, B6 and B9 are major vitamins that are attained from potato. Vitamin C is a major antioxidant vitamin in potato that is very sensitive to light and heat. [21]

### **Vitamins**

In the human diet fruits and vegetables are main contribute of vitamin C. in such countries where potatoes are produced and consumed, potatoes are considered, as a major source of vitamin C. it's the main vitamin in potato tubers. In comparison to other vegetables ascorbic acid concentration in potatoes ranges from moderate to low as listed in some researches. [22] Forty-seven percent of the daily requirement of vitamin C can be provided by 200g of boiled tubers. [23] The vitamin C content

in fresh potato tubers can range from 50 mg/ 100 g after harvesting. [24]

The rich source of ascorbic acid is present in potato tubers, during the period of maturation of potato tubers, ascorbic acid level is decreased. [25] In potato, the amount of ascorbic acid depends upon the genotype, but it is also enhanced by cultivation methods (including environment condition, soil condition and temperature), processing methods and storage conditions. [25],[26] Some research show that in potato genotype vitamin C ranges from 11 to 30 mg/ 100 g. [25],[27] Potato contributes in 20% of dietary intake in Europe, so they are also considered as a worldwide source of vitamin C. potatoes are consistently available because they can be stored and are also the vital source of ascorbic acid. Any up gradation in the content of vitamin C will have a favorable impact on a human diet. [25]

Excessively high concentration of nitrogen fertilizers has a negative influence on vitamin C concentration in tubers; copiously available nitrogen impedes the accumulation of vitamins and tubers maturation, as studies in the nitrogen availability influence on vitamin C concentration. [25] During the development of tubers, the vitamin C level increases, but in mature tubers, it decreases. [27] Ascorbic acid and tuber size have a negative correlation between them. This trait can be easily inherited so that breeding to increase vitamin C content is worthwhile. [25]

Vitamin C also called Ascorbic acid, is a central nutrient in the human diet. Electron donors and antioxidants are primary physiological functions perform by ascorbic acid. Collagen formation, iron absorption, cancer prevention, immunomodulation and maintenance of normal nerve function are directly linked with vitamin C. It is suspicious to reduce the likelihood of strokes, cataracts, hypertension and lead toxicity. Scurvy is caused by vitamin C deficiency, due to weakening of blood vessels, bones and connective tissues, hairs and tooth loss, joint swelling and suddenly death. [25]

In potato, vitamin B group is also present in which the range of B1 is from 0.03-0.2 mg/100g. [28] These levels can vary, dependent upon the genotype. Higher thiamin level is more than 0.08mg/100g in genotype potato, which is more than 10% of the recommended daily allowance of this vitamin in diets with an ordinary potato serving of approximately 150–175 g. In potato tubers, a high amount of thiamin has been detected. [29] Potato processing reduces 5-14% thiamine contents. [30] The flesh color and russet skin potato are rich in vitamin B1. [29] Another vitamin from B group is vitamin B2 also present in potato. This vitamin chemically called riboflavin and is plays a nutritional role in human metabolism. [31] The B2 range in potato from 0.01to 0.07 mg/ 100 g. [28] Variation in concentration is due to genotype and after processing each variety have different B2 concentration. [30] Pyridoxine and B3 are natural source vegetables e.g. potato. The concentration of pyridoxine and B3 is 0.13 to 0.42 and 1.03 to 2.08 mg/100g respectively. At the time of storage B3 increase but vitamin B6 slow rise, at 40 oF. With the rise of temperature, the B3 contents reduce and pyridoxine concentration increases. [32]

#### Minerals

Potatoes are a vital source of trace elements like Se and I but commonly not rich in Ca. [33] The absorption of vitamin C (mineral micronutrients) is stimulated by high levels of organic compounds found in potato tubers, cysteine and different organic and amino acids and compounds having low concentrations and limit their absorption like phytate [0.11% to 0.27% dry matter (DM)] [34] and oxalate (0.03% DM) [35], high potential of availability of mineral elements in potatoes. [36]

In this research revealed that potatoes harvested in Tenerife of eight cultivators determined the presence of Na, K, Ca, Mg, Fe, Cu, Zn and Zn. High concentrations of K, Fe, Cu and Zn are presented by conventional cultivators. The highest and lowest means concentrations of Fe, Cu and Zn are showed by cultivar Cara, respectively. The lower concentrations of Fe, Cu and Zn were found in cultivars Cara and their higher concentrations were found in cultivars Azucena, Palmera and Peluca. All metals are correlated with trace elements. Na shows a negative correlation because is

opposite to the remaining all metals. From the total extracted variance, 70.4% was explained by the first three factors during applying factor analysis. Zn is related to the first factor, Mn and K is with the second factor and Na is negatively related to the third factor. According to the irrigation process and location, factor and cluster analysis tend to separate. When factor analysis was applied to the samples of *Solanum tuberosum*, conventional and newly imported potatoes were well separated. [37]

#### Antioxidants

Antioxidant, substances that are mostly present in food especially fruits and vegetables, these compounds are produced in the human body. Free radical, a material that damages the body cell. An antioxidant has prevented the formation of these free radicals. Increases of these free radicals in body cells create oxidative stress as well as damage the DNA and structure of human body cells. The formation of oxidative excessive stress in body cells enhances the chances of chronic disease e.g. abnormal cell growth, heart cell damages and type 2 diabetes. However, a food rich in antioxidants can help to enhance the body blood antioxidant amount that defense against excessive free radicals formation and prevent the risk of these chronic diseases. [38]

In this study checked the oxidative stress in the human body. Oxidants and free oxygen are played a dual role such as harmful and beneficial. Cigarette smoke, pollution and radiation are major external sources of formation of these radicals in cell metabolisms. The excessive concentration of these radicals forms a complex compound called oxidative stress. This complex molecule is played a vital part in the formation of chronic health diseases and deteriorating illness, for example, are including disorder in the immune system, eye cataract, abnormal growth, neurodegenerative and heart diseases. There are various procedures in the body to prevent oxidative stress by antioxidant which are produced naturally or provide to the body by foods source including fruits and vegetables. [39]

In this research was evaluated on antioxidant capacity and antioxidant contents in potato. Both water soluble and lipid soluble anti-oxidants are present in potatoes. These antioxidants are present in the form of Vitamin C and carotenoid. A study has shown that there is a small variation of antioxidants concentration in "early potato" between the harvested locations. This study also showed that the tubers of potatoes are a rich source of phenolic acids (Chlorogenic acid and catechin). However, the detection shows that the potato has a higher total antioxidant capacity. Moreover, these antioxidants power reduce or prevent the formation of a cancer cell in the human body. [40]

Another study has been found that among colored vegetables potato antiradical activity is very low, out of twenty-five vegetables potato rank is eighteen. But, the variation in antioxidant ranks changes depend upon different varieties, flesh color species have more antioxidant concentration than white flesh. The dietary intake effectively of these bioactive compounds enhance by highly antioxidant activity and phenolic content composition potato varieties. However, the total phenolic content and antioxidant activity are need to measured. [41],[42]

#### Phenolic compounds

*Solanum tuberosum* is the best source of phenolic acid, these are present in the form of phenolic acids. [43],[44] Chlorogenic acid is known as an ester of caffeic acid and quinic acid, which is the major phenolic acids in potato, [45],[46]. Potato peel contains 90% phenolic substance [47] which is present in the form of 3 major isomers, 5-O-caffeoylquinic acid also known chlorogenic acid, 3-O-caffeoylquinic acid also called neochlorogenic acid, and 4-O-caffeoylquinic acid e.g. cryptochlorogenic acid. [48] In several studies found that above 25–72 mg/100 g caffeic acid is present in potatoes. [49]

Excessive of free radicals also called oxidative stress, which injury the proteins, fats and deoxyribonucleic acid, that cause numerous diseases such as cancer, heart disease and cell swell. [50] Potatoes phenolic substances have ability to suppress these free radical/oxidative stress and

provide protection against these chronic diseases. [51]

Both red and purple color potatoes naturally contain phenolic compounds [52] Phenolic acids are directly related to human health which is due to rich antioxidants power. [53] The practical characteristics of red and purple *Solanum tuberosum* are antiradical and natural colorants [52] and influence the safety against toxic compounds. *Solanum tuberosum* is used in both the nutraceutical and food processing industries. [38]

*Solanum tuberosum* is considered the top vegetable crop in the USA, Globally, this is number fourth among all vegetable crops, which consumption of per capita is approximately 135 pounds. chlorogenic acid is a basic polyphenolic compound in *Solanum tuberosum*. Previous studies predict that chlorogenic acid, caffeic acid, vanillic acid, p- coumaric acid, gallic acid and rutin are potato phenolics, and most amount phenolic acid in potato is gallic acid determined by ethanol extracts method. [21]

### Health Benefits

#### Heart disease

High blood pressure also known as hypertension which is an undesirable condition for heart, this is considered a major character in heart disease. Some vegetables have contained nutrients that are beneficial for the human heart. Potato, a tuber vegetable, source of mineral and phenolic compound that plays a major role in reducing blood pressure. Potatoes are a rich source of potassium and can help in lower blood pressure. Many studies result has been shown that increasing consumption potassium by food source is suitable to reduce the risk of heart disease and hypertension. [19]

Potato is a low-cost source of potassium. According to the potassium point of view, among 20 raw vegetables, potato kept high rank and also among in twenty fruits which are consumed in raw form. The 5.3 ounces, medium-size potato provide 620-milligram potassium. It is eighteen percent of the human daily requirement. Some previous evidence identified that increasing the amount of potassium in the diet lowers the blood pressure, reduce the cases of hypertension and decrease coronary heart disease. There is an inverse relationship between dietary potassium and heart disease. [54] Another prediction showed that both cardiovascular disease and cardiovascular disease are reduced by eating a rich potassium diet especially raw vegetables. [55]

Aburto et al. [56] were reviewed that the relationship among mineral e.g. potassium and B.P, CVD, CHD, and hypertension. High potassium in the diet lowers the B.P in patients of hypertension. However, potassium is created no adverse effect on the human body system such as lipid concentration in old age, kidney function in adult and catecholamine concentrations. The twenty-four percent risk of stroke is reduced by consuming the potassium-rich in the diet.

Tuber vegetable (potato) is a vital source of phenolic substances, these are present in the plant for the protection against microorganisms e.g. unicellular and multicellular. [57] Different research works showed that these potatoes source phenolic compound plays a healthy role in human health. Potato has higher phenolic contents when compared to other widespread vegetables for example onion, carrots and tomatoes. [58] The major concentration of the phenolic compound is skin and flesh of potatoes. [59] Both kukoamines and chlorogenic acid are potato source phenolic acid that helps maintain blood pressure. [60],[61] The secondary plant metabolites are phenolic compounds. In potatoes, chlorogenic acid is primarily phenolic acid that constitutes more than 90% of the phenolic compound. [62]

This study has been conducted that there are different dietary sources of food in the market for control hypertension. Chlorogenic acids (CGAs), basically phenolic acid is present in potato. Various evidence on randomized clinical trials (RCTs) was approved that CGAs play better results to reduce, both systolic and diastolic blood pressures and hypertension. Some data of RCTs have been taken, they differ in shape and measurement and limited to the Asian population and funded by CGA



manufacturers. [63]

#### Anticancer

Cancer is basically abnormal growth of cells [64], its growth due to free radicals, this abnormal growth or cancer cell is controlled by natural antioxidants. [65] Some phenolic compounds also produce antiradical substance. Fruits and vegetables are a vital source of phenolic compounds and antioxidants, in which the potatoes are a natural source of, antioxidants (include vitamin C) and phenolic compounds (e.g. anthocyanins and carotenoid). [66] *Solanum tuberosum* vegetable is usually high antioxidant power that depends upon the flesh composition. [27] A potato colorant, carotenoids are powerful antioxidant which is present in varies form (lutein, zexanthin, and violaxanthin). Anthocyanins are natural plant colorants that have directly related to cancer cell prevention. [67] Antiradicals are compounds which ability to protect the cell from abnormality, this is due to oxidative stress also called free radicals. The mechanism is that antioxidants (include beta-carotene, lycopene, vitamins C, E, and A) react with and stabilize free oxygen. However, in this way, body cells can prevent free oxygen injury. [68]

Laboratory studies have been found that with increasing the consumption of rich antioxidants food the chances of abnormal cell growth (cancer) are reduced. Many observers predicted that taking higher antioxidants in the diet that is related to lower the risk of cancer. [69]

This research has been shown that potato (Colored-flesh) is the best way of improving human nutrition. Potato phenolic compounds and antiradical play vital roles in the control of various types of cancer in the human body, in this way these improve the cell abnormality of the colon. This study was proved that the changes in flesh potato within 90 days of storage. With increase the storage time also enhances the phenolic contents and antioxidants activity such as anthocyanins. [70]

Another study predicted that purple-fleshed potatoes are more power to prevent the abnormal growth of colon cells as compared to other varieties. Due to rich antiradical and anti-swelling characteristics, these can prevent the formation of protein (interleukin-6 or IL-6), this protein is promoted to the cancer cells growth in the colon. The extract of potatoes that control the development of cancer cell proliferation. [71]

#### Conclusions

*Solanum tuberosum*, the high composition of nutrients influences the human body. Its vitamins and minerals components regulate body function and improve human health by suppressing the deficiencies. This shows that potato has a strong ability to lower the risk of oxidative stress that leads to cancer and prevent cardiovascular disease. Its phenolic compounds act as antioxidants and improve heart health. This review summarizes the *Solanum tuberosum* nutritional benefit related to the human health claim.

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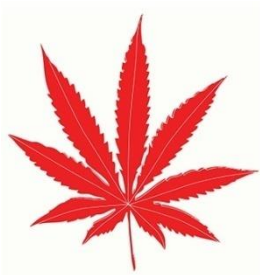
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