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A Scientific Review on Polyphenols Found in Different Fruits in India and Their Health Impact on Humans

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Abstract

Polyphenols are phytochemicals found in various plant-based foods, including fruits, vegetables, and nuts. They have been associated with numerous health benefits, including anti-inflammatory, anti-cancer, and anti-diabetic effects. In India, understanding the polyphenol content of seasonal fruits is essential due to the potential health benefits associated with their consumption. Several studies have analyzed the polyphenol content of various fruits, such as grapes, guavas, mangoes, pomegranates, and amla. The results have shown that the polyphenol content varies among fruits depending on factors such as ripeness, growing conditions, and method of extraction. A diet rich in polyphenols has been suggested to help reduce the risk of chronic diseases such as cardiovascular disease, cancer, and neurodegenerative diseases. Therefore, identifying the polyphenol content of seasonal fruits in India can aid in promoting healthier food choices and potentially preventing chronic diseases.

Keywords: Antioxidant, Polyphenol, Phytochemical, Flavonoid, Phenolic Compounds

Introduction:

Polyphenols are a diverse group of phytochemicals that are found in a wide variety of plant-based foods, including fruits, vegetables, and nuts. They are known to have a range of health benefits, including anti-inflammatory, anti-cancer, and anti-diabetic effects, among others [24, 31]. Understanding the polyphenol content of seasonal fruits in India is important because of the potential health benefits associated with consuming these fruits.

Several studies have examined the polyphenol content of various fruits in India. For example, a study in 2013 analyzed the polyphenol content of four different seasonal fruits: grapes, guavas, mangoes, and pomegranates [34]. The researchers found that the polyphenol content varied significantly among the fruits, with pomegranates having the highest polyphenol content and grapes having the lowest [39]. Another study focused specifically on the polyphenol content of amla, a fruit that is native to India and is traditionally used in Ayurvedic medicine. The researchers found that amla had a high polyphenol content and that it showed significant antioxidant activity [4].

The polyphenol content of fruits can vary depending on factors such as the ripeness of the fruit, the growing conditions, and the method of extraction [13]. A study found that the polyphenol content of mangoes varied depending on the stage of ripeness, with fully ripe mangoes having a higher polyphenol content than partially ripe mangoes [10]. The polyphenol content of pomegranates varied depending on the growing conditions, with pomegranates grown under stress conditions having a higher polyphenol content than those grown under normal conditions [8, 20].

Understanding the polyphenol content of seasonal fruits in India is important because of the potential health benefits associated with consuming these fruits. Research has suggested that a diet rich in polyphenols may help to reduce the risk of chronic diseases such as cardiovascular disease, cancer, and neurodegenerative diseases [29]. In addition, polyphenols have been shown to have anti-inflammatory, anti-diabetic, and anti-microbial effects, among other potential health benefits [24, 31].

Polyphenol contents in some fruits of india:

Polyphenols are secondary metabolites that play a vital role in plant defense mechanisms, and their concentration and composition vary widely among different fruits, depending on factors such as cultivar, ripeness, and environmental conditions.

Guava (Psidium guajava L.) is a tropical fruit that is widely cultivated in India and is rich in polyphenolic compounds such as gallic acid, quercetin, and ellagic acid. These compounds have been reported to possess various health-promoting properties, including antioxidant, anti-inflammatory, and anticancer activities [5]. Guava leaves contain high levels of flavonoids and phenolic compounds, which exhibit antioxidant and antimicrobial activities [42].

Pomegranate (Punica granatum L.), another common fruit in India, is known for its high polyphenolic content, particularly in the peel and seed extracts. The polyphenols in pomegranate have been shown to have various biological activities, including antioxidant, anti-inflammatory, and anti-cancer effects [12]. Pomegranate peel and seed extracts exhibit antioxidant activity and inhibit the oxidation of low-density lipoprotein (LDL) cholesterol [30].

Mango (Mangifera indica L.) is one of the most popular fruits in India and is rich in polyphenolic compounds such as gallic acid, quercetin, and mangiferin. Several studies have reported the antioxidant properties of mango polyphenols, which have been attributed to their ability to scavenge free radicals and inhibit lipid peroxidation [7, 21]. Studies evaluated the antioxidant potential of different mango cultivars and found that polyphenol-rich cultivars exhibited higher antioxidant activity [41].

Grapes (Vitis vinifera L.) are widely cultivated in different agro-climatic regions of India and are a rich source of polyphenolic compounds, including flavonoids, anthocyanins, and stilbenes. The polyphenolic content of grapes and wines has been reported to vary significantly depending on factors such as cultivar, climate, and winemaking practices. Analyzation of the polyphenolic content of different grape cultivars grown in India found that the total phenolic content varied from 149 to 529 mg GAE/100 g of fresh weight [16].

In addition to the above-mentioned fruits, other fruits such as guava, papaya, and jamun have also been found to be rich in phenolic compounds. The bark of jamun (Syzygium cumini) had high levels of phenolic compounds with significant antioxidant activity. The study also showed that the bark extract of jamun had potent scavenging activity against DPPH radicals [36, 37]. Similarly, the peel and pulp of guava (Psidium guajava) and papaya (Carica papaya) have also been found to be rich in phenolic compounds [15, 22]. The peel of guava contained higher levels of phenolic compounds than its pulp, with a total phenolic content of 210.10 mg GAE/100 g FW, while the pulp had a total phenolic content of 116.29 mg GAE/100 g FW [15]. The peel of papaya contained higher levels of phenolic compounds than its pulp, with a total phenolic content of 732.2 mg GAE/100 g FW, while the pulp had a total phenolic content of 293.1 mg GAE/100 g FW [22].

Overall, the results of various studies suggest that fruits commonly found in India are rich sources of phenolic compounds with potent antioxidant activity. The phenolic content and antioxidant activity of these fruits vary depending on factors such as the variety, maturity, and processing techniques. Therefore, further studies are required to understand the factors that influence the phenolic content and antioxidant activity of these fruits and to develop appropriate processing techniques to retain the maximum amount of phenolic compounds in the processed fruits [17, 35].

Table 1: Polyphenolic Content of some fruits in India

Fruit	Polyphenolic Content (mg/100g)
Apple	50-150
Banana	88-220
Blackberry	156-459
Grapes	62-315
Guava	51-129
Mango	100-400
Papaya	95-264
Pomegranate	485-900
Watermelon	20-130

Health Benefits of phenolic compounds:

Phenolic compounds have been found to have several health benefits, including the prevention and treatment of various diseases. In this review, we will discuss the health impacts of phenolic compounds on humans.

Antioxidant activity:

Phenolic compounds are known to possess potent antioxidant activity, which is attributed to their ability to scavenge free radicals and reactive oxygen species (ROS). Free radicals and ROS are generated in the body as a result of normal metabolic processes and environmental factors, such as pollution, smoking, and radiation.

Free radicals and ROS can cause damage to cellular macromolecules, including DNA, proteins, and lipids, leading to various diseases such as cancer, cardiovascular disease, and neurodegenerative diseases. Antioxidants, including phenolic compounds, can neutralize free radicals and ROS, thereby preventing oxidative damage to cells.

Several studies have shown that phenolic compounds can reduce oxidative stress in humans. For example, a study conducted in 2017 found that supplementation with phenolic compounds from pomegranate juice significantly reduced oxidative stress in healthy adults [1].

Cardiovascular health:

Phenolic compounds have been found to have several benefits for cardiovascular health. Epidemiological studies have shown that a high intake of phenolic compounds is associated with a reduced risk of cardiovascular disease.

One of the mechanisms by which phenolic compounds may improve cardiovascular health is by reducing inflammation. Inflammation is a key contributor to the development of atherosclerosis, a condition in which plaque builds up in the arteries, leading to coronary heart disease and stroke. Phenolic compounds have been found to possess anti-inflammatory properties, which may help reduce the risk of cardiovascular disease [3].

Several clinical studies have also shown that phenolic compounds can improve several markers of cardiovascular health, including blood pressure, cholesterol levels, and endothelial function. The consumption of phenolic compounds from dark chocolate led to a significant improvement in endothelial function in healthy adults [23].

Cancer prevention:

Phenolic compounds have been found to possess anticancer properties, which may help prevent the development and progression of various types of cancer. The anticancer properties of phenolic compounds are attributed to their ability to inhibit the growth of cancer cells, induce apoptosis (programmed cell death), and prevent the formation of new blood vessels that supply nutrients to tumors.

Several epidemiological studies have shown that a high intake of phenolic compounds is associated with a reduced risk of several types of cancer, including breast cancer, colon cancer, and prostate cancer.

Several in vitro and animal studies have also shown that phenolic compounds can inhibit the growth of cancer cells and induce apoptosis. A phenolic compound called curcumin, which is found in turmeric, inhibited the growth of breast cancer cells in vitro [18].

Neuroprotective effects:

Phenolic compounds have been found to possess neuroprotective properties, which may help prevent the development and progression of neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease. The neuroprotective properties of phenolic compounds are attributed to their ability to scavenge free radicals and ROS, reduce inflammation, and enhance the activity of antioxidant enzymes in the brain [28, 33].

Several clinical studies have also shown that phenolic compounds can improve cognitive function and memory in humans. Supplementation with phenolic compounds from blueberries led to a significant improvement in cognitive function in older adults with mild cognitive impairment [38].

Anti-inflammatory effects:

Phenolic compounds have been found to possess anti-inflammatory properties, which may help prevent the development and progression of various inflammatory diseases such as arthritis [19], inflammatory bowel disease, and asthma. The anti-inflammatory properties of phenolic compounds are attributed to their ability to inhibit the production of pro-inflammatory cytokines and enzymes.

Several clinical studies have also shown that phenolic compounds can reduce inflammation in humans. For example, a study conducted by researchers found that supplementation with phenolic compounds from extra virgin olive oil led to a significant reduction in inflammation markers in patients with rheumatoid arthritis [32].

Antimicrobial effects:

Phenolic compounds have been found to possess antimicrobial properties, which may help prevent and treat various infections caused by bacteria, viruses, and fungi. The antimicrobial properties of phenolic compounds are attributed to their ability to disrupt the cell membranes of microorganisms, inhibit the activity of enzymes required for their survival, and interfere with their ability to form biofilms.

Several in vitro and animal studies have shown that phenolic compounds can inhibit the growth of various types of microorganisms. A phenolic compound called ellagic acid, which is found in various fruits and vegetables, exhibited potent antimicrobial activity against several pathogenic bacteria [2].

Negative Health Impact:

There is growing evidence that excessive consumption of phenolic compounds may have negative effects on human health. In this review, we will explore the negative impacts of phenolic compounds on human health, including their potential to act as pro-oxidants, interfere with nutrient absorption, and increase the risk of chronic diseases such as cancer, cardiovascular disease, and neurological disorders.

Pro-oxidant effects of phenolic compounds:

Although phenolic compounds are commonly considered as antioxidants, recent studies have suggested that they can act as pro-oxidants in certain conditions. When consumed in large amounts, or when combined with other pro-oxidant compounds such as iron, phenolic compounds can promote the production of reactive oxygen species (ROS) in the body, leading to oxidative stress and damage to cells and tissues.

The consumption of red wine, which is rich in phenolic compounds, can increase the production of ROS in human blood cells. This can lead to DNA damage and oxidative stress, which are both associated with the development of cancer and other chronic diseases [25].

The consumption of pomegranate juice, which is also rich in phenolic compounds, can increase the production of ROS in human blood cells. This can lead to oxidative stress and damage to cellular components such as lipids, proteins, and DNA [14].

Interference with nutrient absorption:

In addition to their pro-oxidant effects, some phenolic compounds have been shown to interfere with nutrient absorption in the body. Specifically, they can bind to dietary minerals such as iron and zinc, reducing their availability for absorption in the body. This can lead to mineral deficiencies, which can have negative effects on various physiological processes in the body, including immune function and cognitive function.

The consumption of tea, which is rich in phenolic compounds, can reduce the absorption of iron in the body. This can be particularly problematic for individuals who are already at risk of iron deficiency, such as pregnant women and children [9].

The consumption of coffee, which is also rich in phenolic compounds, can reduce the absorption of zinc in the body. This can lead to zinc deficiencies, which are associated with impaired immune function and increased susceptibility to infections [27].

Increased risk of chronic diseases:

Phenolic compounds have been shown to have a wide range of beneficial effects on human health, but there is also growing evidence that excessive consumption of phenolic compounds may increase the risk of chronic diseases such as cancer, cardiovascular disease, and neurological disorders.

For example, a study found that the consumption of high levels of tea, which is rich in phenolic compounds, was associated with an increased risk of esophageal cancer [18]. The consumption of high levels of polyphenols, a type of phenolic compound, was associated with an increased risk of prostate cancer [40].

Consumption of high levels of phenolic compounds from turmeric, a popular spice, was associated with an increased risk of liver damage and liver cancer [26]. Also the consumption of high levels of phenolic compounds from olive oil was associated with an increased risk of breast cancer [6].

Consumption of high levels of flavonoids, a type of phenolic compound, was associated with an increased risk of cognitive decline in older adults [11]. This suggests that excessive consumption of phenolic compounds may have negative effects on neurological function and cognitive health.

Conclusions:

In conclusion, this review highlights the significant health benefits of consuming seasonal fruits in India due to their high polyphenol content. Polyphenols are a diverse group of bioactive compounds that are responsible for the antioxidant and anti-inflammatory properties of fruits. The consumption of polyphenols has been linked to a reduced risk of chronic diseases such as cardiovascular disease, cancer, and diabetes.

Several studies have been conducted on the polyphenol content and health benefits of various seasonal fruits in India. The results show that fruits such as pomegranates, mangoes, guavas, and grapes have a high polyphenol content and exhibit potent antioxidant and anti-inflammatory activities. These fruits have also been shown to improve various health outcomes, including lipid profiles, blood pressure, and glycemic control.

However, there is still a research gap in understanding the bioavailability of polyphenols in fruits and their mechanisms of action. The bioavailability of polyphenols is influenced by several factors such as the food matrix, processing, and gut microbiota. Future research should focus on understanding these factors to develop functional foods and supplements that can provide optimal health benefits.

In addition to their health benefits, seasonal fruits are an integral part of the Indian diet and culture. They are also a source of income and employment for many farmers and workers in rural India. Therefore, promoting the consumption of seasonal fruits can have significant economic benefits and contribute to sustainable development.

Public health campaigns, education programs, and interventions can promote the consumption of seasonal fruits in India. These interventions can include fruit and vegetable vouchers, subsidies, and the promotion of fruit and vegetable markets. These interventions can help increase accessibility and affordability of seasonal fruits, especially for low-income individuals who are at high risk of chronic diseases.

Sustainable production practices must also be implemented to reduce the environmental impact of fruit production. Sustainable practices such as organic farming and efficient water management can help reduce deforestation, water depletion, and pesticide use.

In conclusion, the consumption of seasonal fruits in India can provide significant health benefits due to their high polyphenol content. Future research should focus on understanding the bioavailability of polyphenols and their mechanisms of action to develop functional foods and supplements. Public health campaigns, education programs, and interventions can promote the consumption of seasonal fruits and reduce the risk of chronic diseases. Sustainable production practices must also be implemented to promote sustainable development in India. By addressing these issues, the potential of seasonal fruits in improving health outcomes and promoting sustainable development in India can be realized.

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