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Popular Article

Beyond Flavor: The Unwavering Health Benefits of Polyphenols in Tea

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Abstract

Tea is a widely consumed beverage in the world, and its rich content of polyphenols, a family of naturally occurring plant compounds, has fueled growing consumer interest in tea as a healthy beverage. These are naturally occurring antioxidants found in tea leaves. This article follows the evolutionary path of tea polyphenols, beginning in the early 1900s with the pioneering research of Japanese chemist Shigetake Shibata and discovery of the powerful antioxidants known as catechins. The paper systematically classifies the many polyphenols that are prevalent in tea and reveals the complex functions they serve in maintaining cellular health. Every class of polyphenols contributes significantly to the overall health profile of tea, from the predominant green tea catechin, epigallocatechin-3-gallate (EGCG), which is well-known for its antioxidant capabilities, to the intricate interaction between the flavones and arubigins produced during the fermentation of black tea. Beyond the recognizable flavor profiles, tea polyphenols exhibit a complex influence on human health. Their importance in cardiovascular health is discussed, along with the processes that enhance blood vessel function, control blood pressure, and alter cholesterol levels. This review article presents tea as more than a sensory experience, promoting it as a holistic elixir loaded with polyphenolic riches that promise not only flavor but a journey towards increased health and vitality.

Introduction

Tea, a beverage enjoyed by billions worldwide, has long been revered for its soothing warmth and refreshing taste. But beyond its sensory appeal, tea holds a wealth of health benefits, thanks to its rich content of polyphenols, a family of naturally occurring plant compounds. These potent antioxidants play a crucial role in protecting our cells from damage and contributing to overall well-being.

The discovery of polyphenols in tea dates back to the early 1900s when scientists began to investigate the chemical composition of tea leaves. In 1930, a Japanese chemist named Shigetake

Shibata first isolated and characterized a polyphenol from green tea, which he named catechin.In the past few decades, research on tea polyphenols has intensified, with a focus on elucidating their mechanisms of action and identifying specific health benefits. Numerous studies have demonstrated the potential of tea polyphenols in cancer prevention, cardiovascular health protection, neurodegenerative disease management, and other areas. These findings have fueled growing consumer interest in tea as a healthy beverage and have spurred the development of tea-based functional foods and dietary supplements.

Table1: Composition (%) of Black Tea and Green Tea

Compounds	Green Tea	Black Tea
Protein	15	15
Amino acids	4	4
Fibre	26	26
Carbohydrate	7	7
Lipids	7	7
Pigments	2	2
Minerals	5	5
Phenolic compounds	30	5
Oxidised phenolic compounds	0	25

(Vastrad *et al*., 2022)

There are various types of polyphenols found in tea (anon.2023);

1. Catechin

Catechins are a group of polyphenolic compounds found in tea leaves. They are responsible for the tea's characteristic bitterness and astringency. Catechins have been shown to have antioxidant and anti-inflammatory properties, and they may offer protection against chronic diseases such as heart disease and cancer.

Catechins include Epigallocatechin-3-gallate (EGCG),Epicatechin-3-gallate (ECG),Epicatechin (EC) and Epigallocatechin (EGC).

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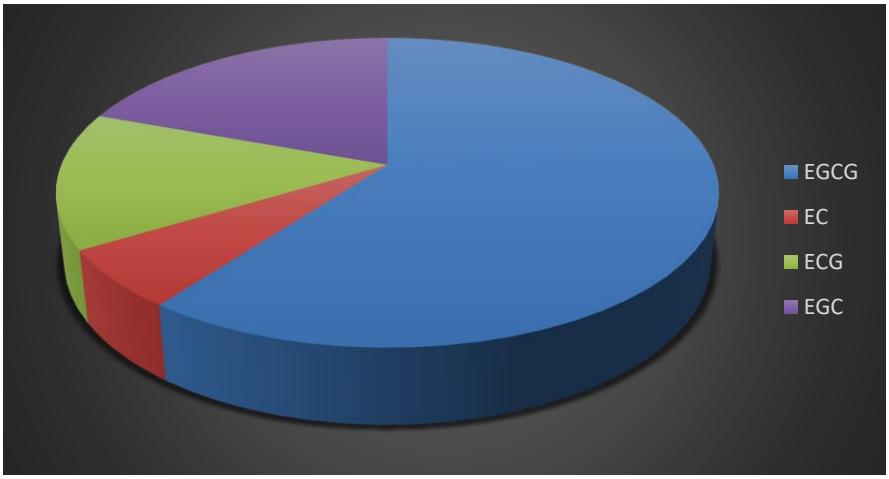

Fig: Relative composition of green tea catechins (Reygaert, 2017)

2. Theaflavins and Thearubigins

Theaflavins and thearubigins are two groups of polyphenolic compounds that are formed during the fermentation process of black tea. They are responsible for the characteristic color, flavour, and aroma of black tea. In addition to their sensory properties, theaflavins and thearubigins also possess various health-promoting properties.The formation of theaflavins and thearubigins occurs during the enzymatic oxidation process of black tea production. This process involves the breakdown of catechins, another group of polyphenols found in tea leaves, into smaller molecules. These smaller molecules then undergo further oxidation and rearrangement to form theaflavins and thearubigins.

3. Flavonoids

Flavonoids, a diverse group of polyphenolic compounds, are abundant in tea, particularly in green tea. These naturally occurring pigments are responsible for the vibrant colors of various fruits, vegetables, and flowers, including the characteristic hues of tea leaves.Among the plethora of flavonoids found in tea, three stand out for their abundance and potential health benefits: kaempferol, quercetin, and myricetin.

4. Phenolic Acids

Beyond the well-known catechins and flavonoids, tea harbors a lesser-recognized group of compounds with remarkable health-promoting properties: phenolic acids. These naturally occurring compounds, often overshadowed by their more prominent counterparts, play a subtle yet significant role in tea's symphony of health benefits.Among the various phenolic acids found

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in tea, some of the most prominent are- Gallic Acid, 4-Hydroxybenzoic acid, Protocatechuic acid, Vanillic acid etc.

Health benefits of Polyphenols

Cancer prevention: Polyphenols in tea, particularly catechins, are linked to cancer prevention. These compounds neutralize harmful molecules, increase detoxification enzymes, inhibit cancer cell growth, trigger apoptosis, and regulate gene expression. Studies have shown that tea drinkers have a lower risk of developing several types of cancer, including prostate cancer, breast cancer, and lung cancer. (Yang *et al.,* 2000)

Cardiovascular health protection: Polyphenols can help to protect against cardiovascular diseases by improving blood vessel function, reducing blood pressure, and lowering LDL (bad) cholesterol levels.

Table 2: Role of various tea polyphenols in Cardiovascular benefits

Tea polyphenols	Cardiovascular benefits
EGCG	Antioxidant activity
Catechin	Anti- inflammatory properties
Quercetin	Lipid- lowering effects
Kaempferol	Endothelial protection

In addition to the above, tea polyphenols have also been shown to have antithrombotic, blood pressure-regulating, and improved vascular function effects. They can also help prevent the proliferation of smooth muscle cells and the formation of new blood vessels, both of which contribute to atherosclerosis progression.

Anti-inflammatory effects: Polyphenols have been shown to reduce inflammation, a key factor in many chronic diseases. Studies have shown that tea drinkers have lower levels of inflammatory markers in their blood.

Weight loss: Polyphenols may help to promote weight loss by boosting metabolism and increasing fat burning. Studies have shown that tea drinkers tend to have a lower body mass index (BMI) than non-tea drinkers.

Improved bone health: Polyphenols have been shown to improve bone health by increasing bone mineral density. Studies have shown that tea drinkers have a lower risk of developing osteoporosis.

Table3: Role of various tea polyphenols in human bone health

Tea Polyphenol	Mechanism of Action	Clinical Evidance
EGCG	Antioxidant, anti- inflammatory,	Reduced risk of osteoporosis

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	enhances osteoblast activity	and hip fractures
Theaflavins	Increased BMD, reduces bone resorption	Animal studies show positive effects
Thearubigins	Antioxidant, anti- inflammatory	Positive effects shown

Neuroprotective effects: Polyphenols may help to preserve cognitive function and protect against neurodegenerative diseases such as Alzheimer's and Parkinson's.Tea polyphenols, including EGCG, theaflavins, and catechins, offer neuroprotective benefits. EGCG scavenges free radicals, reduces inflammation, promotes neurogenesis, and protects against neurotoxins. Theaflavins protect against oxidative stress, improve cognitive function, and reduce neurodegenerative disease risk. Catechins protect against apoptosis and promote autophagy.

Dental health: Tea polyphenols, particularly epigallocatechin gallate (EGCG) in green tea, have been shown to play a significant role in maintaining oral health and preventing various dental diseases. These compounds exert their protective effects through several mechanisms:

1. Antimicrobial activity: Tea polyphenols possess antibacterial properties against various oral pathogens, such as *Streptococcus mutans*, a major contributor to dental caries. By inhibiting bacterial growth and biofilm formation, they can help reduce plaque buildup and lower the risk of cavities.
2. Anti-inflammatory activity: Tea polyphenols exhibit anti-inflammatory properties, which can help alleviate inflammation in the gums and periodontal tissues. Gum inflammation, or gingivitis, is a precursor to periodontitis, a serious gum disease that can lead to tooth loss.
3. Antioxidant activity: Tea polyphenols act as scavengers of free radicals, unstable molecules that can damage cells and contribute to oxidative stress. Oxidative stress is linked to various dental conditions, including periodontitis and oral cancer. By neutralizing free radicals, tea polyphenols can protect cells from damage and promote healing.
4. Enhancing salivary flow: Tea polyphenols can stimulate salivary flow, which plays a crucial role in maintaining oral hygiene. Saliva helps neutralize acids produced by bacteria, preventing tooth erosion and enamel damage.
5. Inhibiting enzyme activity: Tea polyphenols can inhibit the activity of enzymes involved in dental plaque formation, such as alpha-glucosidase and alpha-amylase. These enzymes break down food sugars into simpler forms, providing bacteria with the nutrients they need to thrive.

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Reduced risk of type 2 diabetes: Tea polyphenols, particularlyEGCG in green tea, exhibit promising antidiabetic effects. They enhance glucose uptake, stimulate insulin secretion, suppress gluconeogenesis, reduce oxidative stress, and modulate gut microbiota. Research suggests that regular green tea consumption can improve insulin sensitivity, reduce blood glucose levels, and lower the risk of developing type 2 diabetes.

Conclusion

Tea polyphenols, the diverse array of naturally occurring compounds in tea, hold immense potential in promoting human health. Their antioxidant and anti-inflammatory properties have been linked to a range of health benefits, including cancer prevention, cardiovascular health protection, and neuroprotective effects. As research continues to unravel the mechanisms of action of these compounds, the significance of tea polyphenols in maintaining overall well-being is likely to gain further recognition.

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