



Mini review

Tea and human health: The dark shadows

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HIGHLIGHTS

- Different varieties of tea.
- The major polyphenols present in tea.
- The toxic effects of Green, Black, White, Oolong, Pu-erh Tea.

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ABSTRACT

Tea is one of the most popularly consumed beverage. Depending on the manufacturing process, different varieties of tea can be produced. The antioxidative and antimutagenic potential of tea in cardiovascular diseases, cancer and obesity have long been studied. These therapeutic and nutritional benefits of tea can be attributed to the presence of flavanoids. However, these flavanoids also have certain detrimental effects on human health when their consumption exceeds certain limits. The toxicity of these flavanoids can be attributed to the formation of reactive oxygen species in the body which causes damage to the DNA, lipid membranes etc. The aim of this review is to summarize briefly, the less studied evidences of various forms of toxicity associated with tea and its harmful effects on human health.

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1. Introduction

The long history of tea as a beverage is remarkable and it is grown in many different places of the world. However, all true teas are derived from the leaves of *Camellia sinensis* which is indigenous to China (Chen et al., 2007). The manufacture and processing steps of tea vary with the variety of tea that is desired (Table 1). The freshly plucked leaves undergo one or more of the processes that include withering (reduces the moisture content), rolling (exposes the sap of leaves to oxygen), oxidation (imparts the characteristic flavor to the tea), drying (at temperatures of 85–88 °C) and sorting (on the basis of size of leaf particle) (Martin, 2007). The difference in processing to attain different levels of oxidation determines the variety of tea produced. Whereas Black Tea is produced after complete oxidation of tea leaves, no oxidation is required for Green Tea. Over the years, the potential health benefits of different varieties of tea have been extensively studied. The presence of polyphenolic compounds accounts for their health benefits besides imparting the tea its characteristic flavor (Yao et al., 2004). However, the detrimental effects of tea on human health cannot be overlooked while considering its health benefits. This review focuses on the deleterious effects that different varieties of tea can have on human health which will help the researchers in understanding the potential toxicities associated with its consumption.

2. Varieties of tea derived from *C. sinensis*

The common varieties of tea which are known for their potential health benefits are derived from the leaves and leaf buds of *C. sinensis*, a species of flowering plants in the family Theaceae. Various studies have reported the health benefits of tea derived from this plant which can be attributed to the anti-oxidant activity of the tea flavonoids (Liao et al., 2001; Yang and Landau, 2000).

Green Tea is a non fermented tea, produced by drying and steaming of the fresh tea leaves. It is considered as a prophylactic drink by Chinese since ancient times. It has a very complex composition with maximum of protein content (15–20% dry weight) followed by soluble carbohydrates (5–7% dry weight), minerals and trace elements (5% dry weight) and amino acids (1–4% dry weight) (Cabrera et al., 2006). Green Tea is widely known for its potential health benefits like reduction in the occurrence of cardiovascular diseases (Dogra et al., 2011), inhibition of matrix metalloproteinases (Demeule et al., 2000), use as stimulant, regulation of body temperature, anti-microbial activity (Kubo et al., 1992), regulation of blood sugar and promotion of digestion (Samali et al., 2012).

Black Tea is fully oxidized during processing steps which accounts for its stronger flavor as compared to the other types of teas which are comparatively less oxidized. It is manufactured as a fermented tea product following withering of the tea leaves (Frei and Higdon, 2003). There have been reports showing its association with attenuation of blood pressure (Negishi et al., 2004;

Serafini et al., 1996), reduction of cardiovascular diseases by reversing endothelial vasomotor dysfunction in patients (Duffy et al., 2001), antimutagenicity (Yen and Chen, 1995) and prevention of the onset of ischemic stroke (Arab et al., 2009).

White Tea is another common variety of tea derived from the buds of *C. sinensis* which are subjected to withering followed by drying. Care is taken to minimize the processing protocols as much as possible to prevent oxidation and to leave delicate white leaf hair intact which makes this tea “White” (Hilal and Engelhardt, 2007). White Tea extract, although less studied, is a natural source that is known to effectively inhibit adipogenesis and hence has potential anti-obesity effects (Sohle et al., 2009). Certain varieties of White Tea also exhibit potent antimutagenic activity and act as photo-protective agents to prevent stimulated solar radiation-induced oxidative DNA damage (Koutelidakis et al., 2009; Camouse et al., 2009; Santana-Rios et al., 2001).

Oolong Tea is a partially fermented tea and lies between unfermented Green Tea and fermented Black Tea. It is produced through a unique process including withering under the strong sun and oxidation before curling and twisting. Oolong Tea shows anti-obesity effects (He et al., 2009) and has role in prevention of diabetes (Yasui et al., 2011).

Pu-erh Tea (also known as Pu'er) is prepared from the tender leaves of tall and old plants of Tea. It is also prepared by full fermentation, like Black Tea, but it is fermented for a longer duration hence, it is also called as a “post fermented tea”. The time for which fermentation is done is directly proportional to its quality. Pu-erh Tea has the highest content of caffeine as compared to all the other varieties of tea. In vitro studies have shown the role of Pu-erh Tea in decreasing levels of cholesterol ester and triglyceride in the plasma of rats (Sano et al., 1986). Aqueous extracts of Pu-erh Tea have also shown antimicrobial and antimutagenic activities against strains like gram-positive *Staphylococcus aureus* and *Bacillus subtilis* (Wu et al., 2007). Some of the major health benefits of different varieties of tea have been summarized in Fig. 1.

3. Polyphenols in tea: the key players

Polyphenols are the secondary metabolites of plants and have a great potential as an alternative source of treatment of chronic diseases. Tea is a promising natural source for these bioactive ingredients which play an important role in different nutritional and therapeutic effects of tea to delay the onset of risk factors associated with the development of diseases like cancer and diabetes (Yang et al., 2008). Tea polyphenols have been proposed to have antimutagenic, antiviral, anti-oxidant and anti-inflammatory properties in various biological systems (Lampe, 2003).

The polyphenolic content of tea is mainly attributed to flavanoids including flavan-3-ols and flavanols. Catechins, the major flavanoids present in Green Tea includes epicatechin (EC), epicatechin-3-gallate (ECG), epigallocatechin (EGC) and

Table 1
Different varieties of tea and their characteristic features.

Tea variety	Preparation	Processing	Caffeine content (per 8 oz cup ~ 250 ml) ^a	Steeping time	Water temperature
Green Tea	Mature tea leaves	Non fermented, non oxidized	15–35 mg	2–3 min	Boil cool 3 min
Black Tea	Mature tea leaves	Fermented, fully oxidized	50–65 mg	4–5 min	Boiling
White Tea	Tea buds (immature tea leaves)	Lightly oxidized (15–80%), non fermented	10–25 mg	3–6 min	Boil cool 4 min
Oolong Tea	Mature tea leaves	Partially fermented, semi oxidized (15–80%)	15–50 mg	2–3 min	Boil cool 2 min
Pu-erh Tea	Tender tea leaves	Post fermented, semi oxidized	60–70 mg	3–6 min	Boiling
References	Cabrera et al. (2006) and Chan and Pong (2006)	Heiss and Heiss (2007)	Lin et al. (2003)	Web reference: www.theteaspot.com	

^a 8 oz cup (steeping) for Green Tea and Oolong Tea: 1 rounded tsb. of leaves; Black Tea: 1 level tsb. of leaves; White Tea and Pu-erh Tea: 1 heaping tsb. of leaves.

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