

## Effects of Green Tea Consumption on Psychological Health

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### Abstract

Although the benefits of drinking tea have been acclaimed in the East for centuries, the scientific community of the Western world has only recognized these benefits in the last three decades. Most studies have focused on the positive effects of green tea on human physical health, especially the heart health. However, green tea has been found to benefit human psychological health as well, which in turn is related to one's physical health including the heart health. For decades, research has confirmed the link between coronary heart disease (CHD) and mental illness. Thus, it behooves us to know more about the effects of green tea on the mental health, a significant correlate of the heart health. This article summarizes some interesting properties of green tea that affect human psychological health and recognizes some potential adverse effects of overconsumption.

**Key words:** *Green tea; Camellia sinensis; Effects of green tea; Tea and mental health; Tea and psychological health; Benefits of green tea; Side effects of green tea; L-Th; L-theanine; Polyphenols; Catechins*

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### Introduction

Widely consumed in the East for centuries, green tea has only recently gained popularity in the United States for its health benefits [1,2]. Tea, or *Camellia sinensis*, was first discovered in the northern foothills of the Himalayan Mountains; people chewed the leaves of the plant for medicinal purposes [3]. The dried leaves, leaf buds, and stems of the plant *Camellia sinensis* are used to make several types of teas. To make green tea, one must steam the leaves at a high temperature, then dry them. This process preserves the natural polyphenol compounds (catechins), while black tea or oolong tea leaves are oxidized, producing a variety of theaflavins. The two processes produce teas that have different biological effects [1].

Recently growing interest in Complementary and Alternative Medicine (CAM) in the Western world has supported the consumption of many herbal supplements. The validity of the herbal cures is often questioned because of the paucity of research in this area. However, the situation is different in the case of green tea, which is one of the most highly researched herbs with over 6,000 articles written by researchers worldwide. The diversity of research on green tea consumption is overwhelming. Most of the research addresses effects of drinking

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green tea on human physical health, and these benefits are well known to the scientific and lay community. Green tea has been found to protect drinkers from coronary heart disease, periodontal disease, insulin resistance, obesity, autoimmune disorders, DNA damage, and cancer [8,9]. For decades, research has confirmed the link between coronary heart disease and mental illness. For example, there is a link between heart disease and mental health conditions such as anxiety, depression, bipolar disorder and schizophrenia [10]. The objective of publishing this article in the *Therapeutic Advances in Cardiology* is to highlight the effects of green tea on mental health, which is strongly linked to heart health. The effects of green tea on human psychological health are not as widely studied or known as they are on physical health.

Although the benefits of drinking tea have been recognized since ancient times, medical community of the Western world has only recognized these benefits in the last three decades [2,4]. Based on recent murine and human scientific research, the possible psychological health benefits of green tea are explained below.

### Mood and Depression Improvement

Green tea has the ability to influence individuals psychologically even at superficial levels. For example, drinking hot green tea can contribute to a positive mood. In a recent study, 78 participants were asked to evaluate green tea at 5°C, 25°C, and 65°C temperatures with regard to emotional responses [5]. The green tea at the 65°C was more characterized by positive terms, such as affectionate, calm, good, loving, nostalgic, peaceful, pleasant, satisfied, secure, and warm. Just smelling green tea can improve mood and memory task performance. Another study measured the electroencephalogram (EEG) activity of 28 participants after they smelled either Koushun or Kouju pan-fired green tea [6]. Participants were administered computer-based memory and arithmetic tasks. The researchers found that smelling Kouju tea significantly reduced beta 1 band expression in the right frontal region, suggesting that the avoidance-related emotions associated with the right frontal region were suppressed. In the same study, memory accuracy rates improved slightly with Koushun and significantly with Kouju, compared to warm water.

In a study of mice with post-stroke depression, effects of  $\gamma$ -aminobutyric acid (GABA) green tea (green tea processed to contain high levels of GABA) were examined [7]. Mice that received GABA green tea compared to traditional green tea showed higher activity in modulation of depressive symptoms and the reduction of oxidative stress, leading to restoration of normal behavior. A second study by several of the same researchers found that the green and oolong GABA teas exerted positive effects on mood in mice, but the green GABA tea was found to be more active than oolong GABA tea [8].

In a cross-sectional study, depression levels of 1058 elderly Japanese participants were measured [9]. After accounting for several confounding factors, green tea consumption was found to be independently correlated with the reduction of depressive symptoms. In fact, those who drank 2-3 cups of green tea a day expressed 4% less symptoms than those who drank 1 cup or less; those who drank 4 cups or more expressed 44% less depressive symptoms. In another double blind, randomized placebo-controlled study of 74 healthy participants, researchers noted that the participants who consumed green tea for five weeks showed reduced depressive scores compared with the placebo group [11]. They suggested that the reduction might be attributed to green tea's normalization of the reward function.

### Anti-Anxiety and Relaxation Benefits

In an effort to condense the recent research on  $L$ -theanine ( $L$ -Th; a chemical in green tea), and its physiological role on human health, authors concluded that not only does  $L$ -Th help impart the umami (savory) flavor in tea, it also acts as an anxiolytic (anxiety-reducing) agent [12].  $L$ -Th potentiates GABA receptors generating  $\alpha$ -waves in brain, which produce relaxation leading to quality sleep with less nocturnal motor activity after onset of sleep. Further, this process inhibits blood pressure elevation and reduces anxiety during mental tasks.

In a study of 20 university students performing stressful pharmacy practice, researchers measured salivary  $\alpha$ -amylase activity and discovered that  $L$ -Th ingestion significantly decreased subjective stress by reducing glutamate release [13], which likely occurred through suppressing the autonomic nervous system and hypothalamus–pituitary–adrenal axis excitability. Other studies have found similar  $L$ -Th-induced stress reduction in participants, including those with schizophrenia and schizoaffective disorder [14-16].

### Memory Improvement

Epigallocatechin-3-gallate (EGCG), a natural catechin polyphenol, is the most abundant catechin in green tea. Since EGCG is known to improve cognitive performance and increase antioxidant capacity in normal rats, a study examined the effects of EGCG on human participants' cerebral blood flow (CBF) and cognition [17]. It was found that low doses of EGCG reduced CBF, but had no effect on cognition. However, another study found contrary results [18]. Eight healthy participants experienced a significant increase in theta brain waves between 30 minutes and 1 hour after green tea (EGCG) consumption. Increased theta activity is associated with improved cognitive performance, alertness, and attention. Yet another study focused on the effects of all green tea polyphenols (GTPs), rather than just EGCG, on cognitive performance in stressed Wistar rats [19]. The results suggested that cognitive performance impaired by psychological stress improved with GTPs. In a double-blind study, 12 male participants were given control drinks or drinks containing green tea extract [20]. The participants then performed an fMRI-based N-back task. The researchers found that drinking green tea extract significantly improved task performance by enhancing parieto-frontal connectivity during memory processing.

### Neurological and Cognitive Function

Green tea has a protective role against neurological and cognitive dysfunction, especially in the elderly. In a pilot study, Japanese elderly participants were given 2g of green tea powder for three months [21]. Their Mini-Mental State Examination score improved significantly, suggesting that green tea supplementation might improve cognitive functioning. A Singaporean study of 957 elderly participant found similar results [22]. Both green and black/oolong tea intake was associated with a lower incidence of neurocognitive disorders.

A large-scale epidemiological study examined the relationship between green tea consumption and incidence of dementia by tracking 13,645 elderly Japanese participants over 5.7 years [23]. The researchers found that individuals who drank 5 cups of tea or more developed dementia 27% less often than those who drank less than 1 cup per day. Green tea also protects against Alzheimer's disease. Consumption prevents amyloid plaque formation, degrades existing plaque, and stimulates hippocampal neurogenesis [24-26]. Amnesic mild cognitive impairment (aMCI; a precursor to Alzheimer's) is similarly thwarted by green tea. A study of 2,131 elderly Han Chinese males and females found that men under the age of 70 who drank green tea had a significant reduced risk of aMCI (OR = 0.376) [27].

The benefit from drinking green tea for those with Down Syndrome was highlighted in a study of 29 young adults with Down Syndrome [28]. EGCG is a dual-specificity tyrosine-(Y)-phosphorylation regulated kinase 1A (DYRK1A) inhibitor. DYRK1A overexpression is associated with the intellectual deficits found in Down Syndrome. Compared to the placebo group, the EGCG group had higher accuracy in visual memory recognition and spatial working memory tasks, had improved quality of life and social functioning, and expressed better behavioral control. Thus, the study considered EGCG as a potential therapeutic agent for cognitive enhancement in young adults with Down Syndrome.

### Adverse Effects and Safety

Because green tea is such a popular drink, many consumers overlook its potential negative side effects. Drinking green tea in moderate amounts is safe for most adults. However, the following adverse effects of green tea need to be considered.

Drinking too much green tea, either long-term or in high doses, can introduce enough caffeine to cause "headache, nervousness, sleep problems, vomiting, diarrhea, irritability, irregular heartbeat, tremor, heartburn, dizziness, ringing in the ears, convulsions, and confusion" [29]. Pregnant or breastfeeding mothers should not consume more than 200 mg of caffeine. Additionally, high doses of green tea, specifically taken as green tea extract, can cause liver damage. Other side effects include reduced absorption of iron from food and

increased eye pressure, which is a risk factor for glaucoma. However, serious problems are rare. The average 8oz cup of green tea contains 25mg of caffeine and it would take 400 cups or more to overdose fatally [29].

## Conclusion

Green tea is a health-boosting beverage that offers many physiological and psychological benefits. L-Th appears to be the most important chemical in tea regarding positive psychological influence, followed by other polyphenols in tea (EGCG being the most abundant and potent catechin). What makes L-Th so interesting is that it is almost exclusively found in *Camellia sinensis*; thus, green tea offers benefits that cannot be found elsewhere. Currently, the effects of green tea are far from being fully explored by the scientific community. Some areas that future research should examine are the effects of green tea on individuals with autism spectrum disorder, bipolar disorder, and other neurocognitive disorders. However, at the present time, it is well accepted that freshly brewed green tea is not only enjoyable by many people all over the world, but it also appears to be an economical and safe way to prevent heart disease and support good mental and physical health.

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