

# What every dentist should know about tea

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Tea is one of the most frequently consumed beverages in the world, second only to water. Repeated media coverage about the positive health benefits of tea has renewed interest in the beverage, particularly among Americans. This article reviews the general and specific benefits

of drinking tea, as well as the potential negative aspects of tea consumption.

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Tea has been a staple of Chinese life for so long that it is considered to be 1 of the 7 necessities of Chinese culture.<sup>1</sup> The popularity of tea should come as no surprise considering the recent studies conducted confirming tea's remarkable health benefits.<sup>2,3</sup> The drinking of tea dates back to the third millennium BCE, when Shen Nong, the famous Chinese emperor and herbalist, discovered the special brew. According to legend, the emperor was boiling water when leaves from a wild tea bush accidentally fell into his simmering pot. Since then, tea has been used in Chinese culture for medicinal purposes, religious practices, and personal enjoyment.<sup>1</sup> In time, tea spread in popularity, and as of 2011, Great Britain had the highest tea consumption in the world.<sup>1</sup>

## Varieties of tea

All true teas are derived from the leaves of the *Camellia sinensis* plant, which is indigenous to China.<sup>2</sup> Much of the medicinal properties of tea have been attributed to its antioxidant content, specifically the class of flavonoids/polyphenols called *catechins*.<sup>3</sup> The 4 main varieties of tea (green, black, oolong, and white) all undergo similar processing and manufacturing. The main difference between these teas is their polyphenolic content, which depends on the degree of oxidation or fermentation that the leaves undergo.<sup>2</sup> Green tea is non-fermented and contains a higher catechin concentration than most teas. This is due to the inactivation of the polyphenol oxidase present in the tea, which is an important catalyst in the oxidation reaction that occurs during processing.<sup>3</sup> When green tea is manufactured, its leaves are withered in sunlight for 2 hours then steamed at extremely high temperatures. This process deactivates the oxidative enzymes effectively, leaving the polyphenols in

their original form.<sup>4</sup> Epigallocatechin-3-galate (EGCG) is the principal bioactive catechin left intact in green tea and the one responsible for many of its health benefits.<sup>3</sup> By contrast, black tea is fully oxidized/fermented during processing, which accounts for both its stronger flavor and the fact that its catechin content is lower than the other teas.<sup>2</sup> Black tea's fermentation process is initiated by withering the leaves for up to 18 hours.<sup>1</sup> Next, the leaves are machine-rolled to break up the plant cells (in order to hasten the oxidation process); at that point, the leaves are incubated in a climate-controlled room where the oxidation process is completed.<sup>1</sup> Polyphenol oxidase, the enzyme responsible for oxidation, converts the original polyphenols into other compounds such as theaflavins, theaflagalins, and thearubigens.<sup>4</sup> The degree of fermentation can be carefully controlled to create many different varieties of tea. Oolong tea is partially oxidized (somewhere between green and black tea) and undergoes what may be the most difficult and time-consuming method of processing.<sup>2</sup> The oolong process is tightly controlled and includes shaking and drying the leaves in bamboo baskets to bruise the edges lightly.<sup>1</sup> Shortly after, the leaves undergo a short fermentation period and then a firing process to prevent further oxidation.<sup>1</sup> While green tea might be better known for its health benefits, white tea might actually offer more.<sup>1</sup> White teas are made from young leaves and immature buds and undergo no fermentation or processing at all, which allows them to retain the highest possible concentration of catechins.<sup>2</sup>

## Antioxidants

The antioxidant capability of catechins may be the best-known benefit of drinking tea. In the human body, compounds

known as reactive oxygen species (ROS) are formed through normal aerobic cellular metabolism. During this process, oxygen is partially reduced to form a reactive radical as a byproduct in the formation of water. ROS are helpful to the body because they assist in the degradation of microbial disease.<sup>5</sup> However, ROS also contain free radical electrons that can wreak havoc on the body's normal functions.<sup>5,6</sup> The list of disorders with a positive correlation to ROS includes cancer, autoimmune disorders, heart disease, gastrointestinal disease, cataracts, Alzheimer's disease, and Parkinson's disease.<sup>6</sup> ROS and free radicals may be the most significant contributors to the aging process of the human body.<sup>5</sup>

Antioxidants—such as the catechins found in tea—are electron donors, meaning that they contain free electrons that can be paired with the damaging single electrons found in ROS.<sup>6</sup> This pairing reduces the tendency of free radicals to pair with electrons found in healthy body tissues, preventing a chain reaction of damaging effects.

## Cardiovascular benefits

The endothelial cells of the body that line the circulatory system and maintain permeability produce nitric oxide, a substance that helps protect the cells by acting on the vascular smooth muscle to relax blood vessels. Nitric oxide has been indicated as an anti-atherosclerotic agent, preventing pathologic hardening of the blood vessel walls. Catechins found in tea have a similar effect on the blood vessels by promoting vasodilation.<sup>7</sup> In addition, the antioxidants in tea help prevent oxidant injury when the blood supply is restored after a period of ischemia or hypoxia.<sup>8</sup> Studies have shown a link between flavonoid consumption and a significant reduction in coronary heart disease.<sup>9</sup> This

finding was confirmed in a 2001 study by Arts et al, who found a significant inverse relationship between tea consumption and ischemic heart disease.<sup>10</sup> Moreover, a 2011 study by Deka & Vita reported that the flavins in black tea and catechins in green tea inhibit platelet aggregation in rabbits; this helps reduce cardiovascular disease caused by plaque buildup.<sup>11</sup> Many of the aforementioned studies had limitations, and additional research is necessary.

## Neurological benefits

After tea is consumed, the polyphenols are modified chemically by intestinal enzymes rendering them fit for absorption by the gastrointestinal tract.<sup>12</sup> Once absorbed, the compounds travel in the bloodstream, where they are delivered to various tissues and organs. Certain polyphenols are unable to cross the blood brain barrier (BBB), a separation between blood and the extracellular fluid of the brain that manages the passage of various metabolites, drugs, and nutrients.<sup>12</sup> However, the polyphenolic compounds in tea (specifically EGCG) have demonstrated an ability to cross the BBB, which can impact brain function, neurodegenerative disorders, and psychiatric disorders.<sup>12</sup>

A number of new studies have suggested that the compounds found in green tea may be helpful in treating patients with Alzheimer's disease and other forms of dementia.<sup>13</sup> Alzheimer's disease produces nonfunctional proteins (known as  $\beta$ -amyloid plaques) that attach to nerve cells in the brain. In a 2013 study, British scientists created balls of amyloid proteins similar to the toxic  $\beta$ -amyloid plaques present with Alzheimer's disease.<sup>13</sup> The amyloid balls were treated with EGCG (the principal catechin found in green tea), which distorted the balls so that they could no longer attach to nerve cells.<sup>13</sup> A 2012 animal study in China found that green tea polyphenols (administered both in vivo and in vitro) had a protective effect against neurotoxicity caused by  $\beta$ -amyloid proteins.<sup>14</sup>

In a 2012 study, Wang et al found that EGCG had an effect on neurogenesis—a function that is important for brain plasticity in that it affects learning and memory.<sup>15</sup> When mice used in the study were injected with EGCG, they showed a marked improvement in navigating mazes, a sign of improved spatial cognition.<sup>15</sup>

## Reducing cancer risk

The primary form of tumor cell degradation induced by radiation and chemotherapy occurs via apoptosis, a programmed cell death. Excessive apoptosis causes atrophy, whereas an insufficient amount results in uncontrolled cell proliferation, as seen in cancer.<sup>16</sup> A 2012 study on green tea catechins by Connors et al reported that treatment with EGCG can trigger apoptosis in prostate cancer cells (as evidenced by DNA fragmentation and cellular morphology).<sup>17</sup>

Another 2012 study found that Chinese women who drank an average of 2-3 cups of tea (mostly green) every day reduced the risk of digestive system cancers—specifically colorectal, stomach, and esophageal cancers—by 21%.<sup>18</sup> According to epidemiological evidence, black tea consumption generally is not associated with a reduced risk of cancer.<sup>19</sup> While many of these studies are hopeful, there are also reports that tea has no association with cancer, with some actually recording an increased risk of cancer.<sup>19</sup>

## Other health benefits

Black tea is the most popular variety in the western world, and green tea is the favorite in Asian countries.<sup>1</sup> Cigarettes also are one of the most highly consumed products in Asia; however, Asian countries—Japan in particular—have surprisingly low incidences of arteriosclerosis and lung disease per capita.<sup>20</sup> This quandary is known as the *Asian Paradox*.<sup>20</sup> Scientists theorize this paradox is the result of a high consumption rate of green tea, which may reduce the deleterious effects of cigarette smoking.<sup>20</sup>

While the emphasis in recent years has been on green tea and its health benefits, other teas may be beneficial, as well. Black tea has been reported to lower blood pressure, due to the polyphenolic effect on blood vessel function.<sup>21</sup> White tea has been shown to have an anti-adipogenic effect, a quality that could be instrumental in battling obesity.<sup>22</sup> Certain tea varieties also have been associated with the prevention of diabetes, stroke, and osteoporosis.<sup>3</sup>

## Oral health

One common side effect of habitual tea drinking is tooth discoloration.<sup>23</sup> Discoloration is the result of pigmented

compounds known as *chromogens*, which are present in both coffee and tea, and have an affinity for dental enamel.<sup>23</sup> The tannins and other polyphenolic compounds in tea worsen the situation by increasing chromogens' ability to attach to enamel.<sup>23,24</sup>

Despite its potential esthetic disadvantage to teeth, tea consumption has been shown to help improve overall oral health. Green tea extract has shown inhibitory effects on certain bacteria that are responsible for causing dental caries and periodontitis.<sup>25</sup> A 2013 study by Araghizadeh et al reported that green tea extract exhibited inhibitory activity on *Streptococcus mutans*, the primary bacteria responsible for dental caries, as well as other periodontopathic bacteria, including *P. gingivalis*, *A. actinomycetemcomitans*, and *P. intermedia*.<sup>25</sup> A 2010 study by Koyama et al demonstrated that consuming >1 cup of green tea/day was associated with a significantly decreased risk for tooth loss.<sup>26</sup>

Oolong tea has also been shown to help reduce dental caries.<sup>27</sup> The mechanism depends on the oolong tea polyphenols, which inhibit the function of glucosyltransferase, an important enzyme that allows *S. mutans* to attach to enamel.<sup>27</sup>

A 2013 in vitro study reported that green tea polyphenols (specifically EGCG) displayed an inhibitory effect on the growth and development of oral squamous cell carcinoma cells.<sup>28</sup> A 2005 study by Halder et al studied patients with oral leukoplakia, a precancerous lesion that has been reported in half of all cases of oral cancer.<sup>29</sup> A group of patients in the study were given 3 cups of black tea every day for 1 year. The results from this group showed a significant reduction in the patients' leukoplakia and precancerous cellular damage.<sup>29</sup>

## Negative effects

Despite the tremendous potential health benefits of tea, certain negative effects that cannot be overlooked have been reported as well. One such effect that relates to dentistry is the fluoride content of tea.<sup>2</sup> Regular strength tea (specifically black tea) contains fluoride levels as high as 6.5 ppm, while the US Environmental Protection Agency recommended fluoride levels for public drinking are 1.2 ppm.<sup>30,31</sup> This relatively high fluoride content could put patients at risk for skeletal fluorosis and developmental tooth defects.

In addition, the phenolic compounds present in tea, although usually associated with tea's benefits, can act as pro-oxidants, causing oxidative stress by generating reactive oxygen species.<sup>2</sup> This mechanism is not understood completely, and additional research is necessary.

### Summary

Tea drinking continues to gain popularity in America and in the western world as people are learning of its numerous health benefits. Published studies and research have demonstrated that the various antioxidants present in tea are responsible for benefits ranging from the treatment of cancer and cardiovascular disease to fighting obesity and diabetes. Dialogue concerning the benefits from drinking tea has also entered the sphere of dentistry, as it has been shown to prevent dental caries, reduce tooth loss, and improve overall oral health. Despite all these positive results reported, there also have been studies on the negative consequences of excessive tea consumption. Additional research is necessary to determine the various effects of tea on general and oral health.

### Author information

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