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Review

A minireview of effects of white tea consumption on diseases

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ABSTRACT

Tea, is the most common beverage obtained from leaves of *Camellia sinensis* plant. Tea is classified as green, yellow, white, oolong, black and Pu-erh due to fermentation process. Important differences of tea species are originated from cultivating conditions of the plant, harvesting procedures and processing of leaves.

Green tea and white tea are not fermented, black tea is full fermented and oolong tea is semi-fermented. The most produced tea types in the world are black tea, green tea, oolong tea and white teaspoon respectively. The white tea which has very young tea leaves and buds covered with small, white-silver fuzz is harvested once a year in early spring and has a very mild, sweet taste. There are more catechin and its derivatives in white tea than other tea species. Especially, because of the fact that containing epigallocatechin gallate (EGCG) component, white tea has positive effects on health. Cardioprotective, antidiabetic, neuroprotective, anticarcinogenic effects, antimutagenic activities, antimicrobial and anti-obesity properties are important effects of white tea. For these reasons; white tea is known to have protective effects against cardiovascular diseases, cancer, diabetes mellitus, obesity, central nervous system and microorganism-based diseases.

In this review, the production of white tea, its composition and the effect of it on health were examined and compared with different tea types.

1. Introduction

Tea, is obtained from leaves of the plant known as Camellia sinensis and is the most common beverage that take place on the second after water in the world. (Dai et al., 2017). Tea which is classified in Theaceae family and mainly has two types as Camellia sinensis var. sinensis and Camellia sinensis var. assamica, grown in hot and moist climates, is a perennial and evergreen plant. (Atalay & Erge, 2017). Camellia sinensis which is particular to China; is a perennial, hardy, small-leaved plant (Avins & Quick, 2009, pp. 1–39; Fisunoğlu & Besler, 2008, pp. 1–24). Tea, is classified differently as green, yellow, white, oolong, black and Pu-erh etc, depending on fermentatiton process. Important differences of tea species are originated from cultivating conditions of the plant, harvesting procedures and processing of leaves. (Yi et al., 2015; Wang, Provan, & Helliwell, 2000). Each tea variety has a different composition depending on how leaves are processed, as well as factors such as ripeness, geographical location and agricultural practices (Dias et al., 2013). Tea is a health alternative to coffee and alcohol, because of the facts that not containing additives, being completely natural, fat-free-energy-free and having low caffeine content (Sharma, Joshi, Baldi, Khatri, & Dube, 2013, pp. 56–64). Every year, approximately 2.5 million tons of dry tea are produced. Generally the countries where it is produced are; India, China, Sri Lanka, Turkey, Russia and Japan. "US Food and Drug Administration (FDA)" informs that tea is a healthy drink for human health and suggests consumption (Wu & Wei, 2002). When the per capita consumption is considered, Turkey is in the leading position in consumption of tea in the world. Annual consumption per capita in 2011 was reported to be 3.157 kg. Ireland is in the second place with consumption of 2.191 kg per capita (Shannon, Jaiswal, & Abu-Ghannam, 2018) (see Fig. 1).

1.1. History and development of tea

The history of white tea dates back to the time of the Song Dynasty Emperor Hui Zhong in China in the years of 600 AD, that was remained concealed for countries outside of China for centuries. The white tea of modern age emerged during the Qing Dynasty in 1796. From this period on, white tea has been produced and distributed as bulk tea. Later, after 1885, tea clones as "Big White", "Small White" and "Narcissus" which have big fleshy buds, were obtained by selection as "raw material" of all white tea varieties including "Silver Needles" (Ilgaz & Polat, 2012). Tea production in the world is made in tropical

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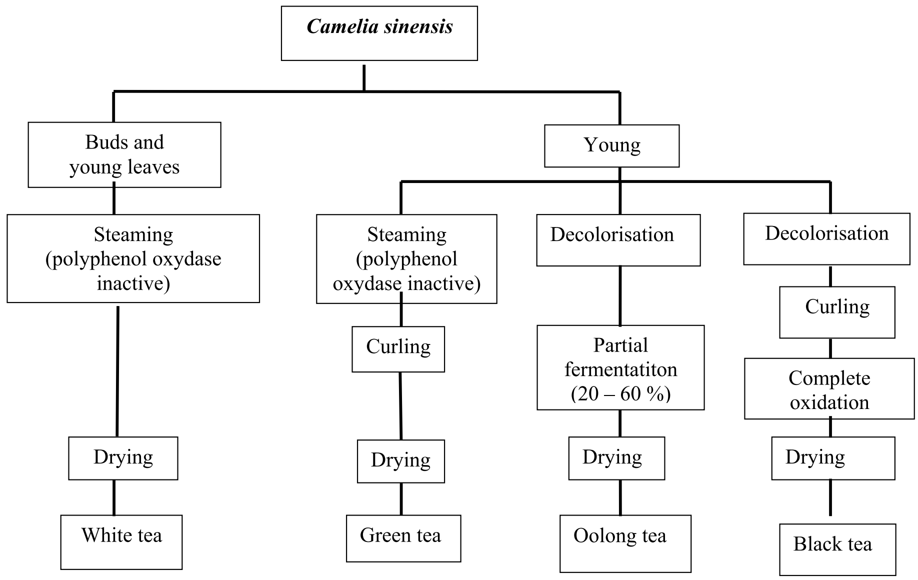

Fig. 1. Production stages of tea types.

and subtropical climates, in moist regions where the annual total precipitation is abundant and regularly distributed to months. The optimum temperature for the development of tea shoots is between 18 and 30 °C (Mahmutoğlu, 2012). Most high-quality tea plants are grown at altitudes of 1500 m above sea level, that provides plants growing more slowly and having better tastes (Sharma et al., 2013, pp. 56–64). The tea plant produced mainly in two ways as seed (generative) and slip (vegetative) (Mahmutoğlu, 2012). The setting seed of tea takes about 4–12 years and a new tea plant is being ready for harvest in about three years (Sharma et al., 2013, pp. 56–64). The top bud and the first and second leaves following the top bud from the tip of the young shoots on tea plant are picked up (Mahmutoğlu, 2012). The tea shoot which is formed from these two full leaves and a top bud called as two and a half leaves (Ilgaz & Turna, 2012).

1.2. Tea production

Black tea, mostly consumed in western countries comprises 78% of all teas produced worldwide, where green tea, generally consumed in Asian countries comprises 20% and oolong tea mainly consumed in China comprises 2% (Yang & Landau, 2000). The annual white tea production is about 2.000 tons. This value is only 0.1% of black tea production. As much as 90% of white tea production is being occurred in China. (Anonymous, 2015). In recent years, with the strong international market demand, white tea production reached 15700 tons in 2014, while the figure reached 5140 tons only in China in 2009 (Tan, Engelhardt, Lin, Kaiser, & Maiwald, 2017). Production stages of tea types are given in (Dias et al., 2013; Şahin & Özdemir, 2006).

White tea is harvested once a year in early spring. Compared to other tea types, white tea is devoid of fermentation stages such as oolong or black tea or enzyme deactivation such as green tea and only passes through decolorisation and drying (Tan et al., 2017). The name of "white tea" originates from silky white feathers covering unripe leaves and buds and it has a delicate and sweet taste different from unrivaled flavor of green tea (Damiani, Bacchetti, Padella, Tiano, & Carloni, 2014).

To prevent oxidation, tea leaves are immediately evaporated and dried after collected. This tea has a very light and sweet taste. (Rusak, Komes, Likić, Horžić, & Kovač, 2008). Depending on the raw material and the different collection standards, white tea is classified in 4 main groups. These are; Yin Zhen Bai Hao (Silver Needle), Bai Mu Dan (White Peony), Gong Mei (Tribute Eyebrow) and Shou Mei (Noble, Long Life Eyebrow). The best quality white teas are "Silver Needle" produced from picked single buds of "big white tea" types and "White Peony" produced from single buds of "two/three – leafed big white tea" or "narcissus white" types, produced in China. (Lin, Xia, & Liu, 2017). Gong Mei (Tribute Eyebrow) and Shou Mei (Noble, Long Life Eyebrow) are of lower quality (Ilgaz & Polat, 2012).

1.3. Composition of white tea

A diversity of these compounds has been identified, including alkaloids, polyphenols, flavonoids, aromas, vitamins, minerals, amino acids, protein, polysaccharide, lignin and methylxanthines (caffeine, theophylline ve theobromine) and organic acids (Seeram et al., 2006). Moreover white tea polysaccharide is a kind of water-soluble polysaccharide isolated from white tea. Monosaccharides of oolong tea polysaccharides were composed of D-rhamnose, L-arabinose, D-galactose, and D-glucose (Jiang & Xiao, 2015; Kwan-Wai et al., 2017).

Apart from its energizing effect, phenolic compounds, especially flavonoids, due to methylxanthines such as caffeine have attracted much attention among tea phytochemicals. (Cabrera, Giménez, & López, 2003). Flavonoids, which are important for health, have unique biological properties and detected approximately 4000 different types in nature, are classified as flavonols, flavones, catechins, flavanons, anthocyanidins and isoflavonoids. (Firenzuoli, Gori, Crupi, & Neri, 2004). Important phenolic compounds found in tea leaves are catechins and their derivatives which make up 30% of dry weight of tea. Epigallocatechin gallate (EGCG), epigallocatechin (EGC), epicatechin (EC) and epicatechin gallate (ECG) are the major catechins found in white tea. EGCG, which constitutes 50–80% of the total catechins in tea leaves, is the most abundant catechin and thought to contribute to the positive effects associated with tea. (Hilal & Engelhardt, 2007). The primary bioactive components in the white tea are 8 types of catechins including 4 types of epicatechins as (−)-epigallocatechin (EGC), (−)-epicatechin (EC), (−)-epigallocatechin gallate (EGCG), (−)-epicatechin gallate (ECG) and 4 types of transcatechins as (+)-gallocatechin (GC), (+)-catechin (C), (−)-gallocatechin gallate (GCG) and (−)-catechin gallate (CG) together with gallic acid (GA) and caffeine (Lin et al., 2017). Each tea type has a diffent composition. The catechin contents of tea is both dependent on how the leaves are processed before drying and the geographical location and growing conditions. Flavonoid concentration is also dependent on tea type (eg: mixture, decaffeinated, instant) and preparation (eg: amount used, brewing time, temperature) (Dias et al., 2013). For example, in a study conducted, chemical and sensory analysis showed that the most suitable infusion conditions for white tea were a water temperature of 98 °C and a brewing time of 7 min (Pérez-Burillo, Giménez, Rufián-Henares, & Pastoriza, 2018). It has been reported that; catechins were relatively at high concentrations in white tea while theaflavin and thearubigins were at low concentrations. EGCG, was defined as major polyphenol both in white and green tea, but EGC and ECG are at higher concentrations together with gallic acid, caffeine and theobromine in white tea. (Tenore, Stiuso, Campiglia, & Novellino, 2013). Some reports show that concentrations of total polyphenol, catechin, caffeine, gallic acid, theobromine, EGC, ECG and EGCG are significantly higher in white tea than in green tea (Hilal & Engelhardt, 2007; Santana-Rios et al. 2001). Therefore, the possible high antioxidant activity of white tea may be associated with higher concentrations of several major components (Santana-Rios et al., 2001). Despite some studies reporting that green tea is a richer polyphenol source than white tea, it is known that the strongest antioxidant activity sequence is white, green and black tea (Rusak et al., 2008).

During oxidation of tea with polyphenol oxidase enzyme, gallic acid complexes such as theaflavin, theaflavinic acids, thearubigins and proanthocyanidin polymers and catechins are formed. (Song, Xu, Liu, & Feng, 2012). Theaflavins are characterized by a benzotropolone ring structure and a bright red-orange color and give taste native to black tea (Khan & Mukhtar, 2007), A typical tea, prepared by 1 g dried leaf in 100 mL of water for 3 min, contains 250–350 nm g tea solid materials which 30–42% of them is catechin and 3–6% of them is caffeine (Yang & Landau, 2000). Tea also contains flavonol (kaempferol, quercetin and myricitin) in small quantities of the form of glycosides.

There are phenolic compounds, free amino acids except alkaloids in tea plant. In tea plant, 26 different amino acids were found in the dry matter between 1 and 4%. Many of the free amino acids give flavor and aroma unique to the tea (Koca & Bostancı, 2014). Teanin is one of the most common amino acids found in tea leaf and the amount varies from 1 to 2% in dry matter. Some free amino acids have physiological and pharmacological activities. For example, teanin has the effects of relaxing, enhancing concentration and improving learning ability. It is also reported that it prevents certain types of cancer and cardiovascular diseases, strengthens the immune system. Another free amino acid γ-aminobutyric acid (GABA) has the effects of the urinary exacerbation and sedative (Zhao et al., 2013). During decolorisation, the level of amino acid found in tea increases. In the fermentation phase, amino acids form aroma compounds by being oxidised (Ekborg-Ott, Taylor, & Armstrong, 1997). Amounts of aspartic acid and glutamic acid are similar to those of green tea according to tea types, and other amino acids are most abundant in white tea among tea varieties. (Alcázar et al., 2007; Horranni & Engelhardt, 2013).

1.4. Antioxidant potential of white tea and effects on health

High amounts of catechin, especially white tea containing EGCG, this component and other important tea components have many benefits to human health due to strong antioxidant substances that play an important role in protecting against diseases (Almajano, Carbo, Jiménez, & Gordon, 2008). For this reason; tea can be taken as a good complement to antioxidant intake in human nutrition. (Alarcón, Campos, EdwardsLissi, & López-Alarcón, 2008). Many epidemiological studies, animal testing and *in vitro* studies; proved that white tea has potential protective effects on health. White tea extract and EGCG efficacy were researched in a study of inhibition of hepatic dysfunction of a pro-carcinogenic compound, Benzo (a) pyrene (BaP). It has been determined that, both EGCG and white tea extract were showing antioxidative efficacy, there was a potential utility of white tea extract as a preventive measure to limit oxidative damage to hepatocytes and RBCs caused by BaP (Rangi, Dhatwalia, Bhardwaj, Kumar, & Dhawan, 2018). These effects of white tea are summarized in Table 1.

Table 1
Potential protective effects of white tea on cardiovascular diseases, cancer, diabetes, obesity, central nervous system and diseases caused by microorganisms.

Protective effects of white tea					
Cardiovascular diseases	Cancer	Diabetes mellitus	Obesity	Central nervous system	Diseases caused by microorganisms
Anti-thrombogenic activity (Hertog, Feskens, Kromhout, Hollman, & Katan, 1993)	Anti-mutagenic activity (Bhattacharya, Mukhopadhyay, & Giri, 2011)	Anti-diabetic activity (Abolfathi, Mohajeri, Rezaie, & Nazeri, 2012)	Induction of lipid metabolism in the liver (Murase et al., 2002)	Anti-stress activity (Kimura, Ozeki, Juneja, & Ohira, 2007)	Anti-microbial activity (Shagana & Geetha, 2017; Von Staszewski, Pilosof, & Jagus, 2011)
Hypotensive activity (Yokogoshi et al., 1995)	Anti-carcinogenic activity (Carvalho, Jerónimo, Valentão, Andrade, & Silva, 2010; Genkinger et al., 2012)	Hypoglycemic activity (Mackenzie et al., 2007)	Lipase inhibition (Chantre & Lairon, 2002)	Stimulating effect (Liu, Liang, & Kuang, 2011)	Anti-fungal activity (Hirasawa & Takada, 2004)
Anti-inflammatory activity (Stangl, Lorenz, & Stangl, 2006)	Anti-inflammatory activity (Mitscher et al., 1997)	Reducing insulin resistance (Islam, 2011)	Thermogenic activity (Chantre & Lairon, 2002; Dulloo et al., 2000)	Anti-depressant activity (Zhu et al., 2012)	Anti-viral activity (Weber et al. 2003)
Antioxidant activity (Cheng, 2000)	Reducing DNA damage (Sharangi, 2009)	Antioxidant activity (Song, Hur, & Han, 2003)	Appetite regulation (Liao, 2001)	Antioxidant activity (López & Calvo, 2011)	
	Antioxidant activity (Moderno, Carvalho, & Silva, 2009)	Hypocholesterolemic activity (Maron et al., 2003)			
	Anti-angiogenic activity (Cao & Cao, 1999; Sharangi, 2009)	Lipolytic and antiadipogenic activity (Söhle et al., 2009)			
		Hypolipidemic effect (Huang & Lin, 2012)			

1.5. Cardioprotective effects

The occurrence of cardiovascular diseases depends on a large number of factors that can be modulated by dietary components. Oxidative stress (OS) in cardiac and vascular myocytes is associated with cardiovascular tissue damage. (Dhalla, Temsah, & Netticadan, 2000). Flavonoid intake has been shown to be inversely associated with coronary heart disease mortality (Hertog, Feskens, & Kromhout, 1997). Catechins in tea show an effective cholesterol-lowering effect by decreasing cholesterol absorption in the intestine and increasing fecal excretion of cholesterol and total lipids. In a study conducted on rats to research the cardioprotective effect of EGCG, one of tea catechins; four groups were formed as; standard diet (control group), standard diet + EGCG (positive control group), high cholesterol diet and high cholesterol diet + EGCG. Serum triglyceride, total cholesterol, LDL-cholesterol, VLDL-cholesterol and cardiac risk ratios increased significantly in rats fed diet containing high cholesterol compared to the other groups. Serum lipid profiles of rats fed diet with high cholesterol given EGCG were found at levels close to normal. Remarkably, positive control group rats maintained the lipid profile better than control group rats (Zhong, Huan, Cao, & Yang, 2015). In a study that the effects of tea polyphenols on lipid and glucose metabolism in human liver cells were researched, it has been confirmed that the white tea has a higher hypocholesterolemic potential than the green and black tea (Tenore et al., 2013).

Quercetin and L-teanin reduce blood pressure in animals and in humans and so they reduce the risk of cardiovascular diseases. (Tijburg, Mattern, Folts, Weisgerber, & Katan, 1997; Yokogoshi et al., 1995). In the regulation of blood pressure, cardiac output, blood volume, nervous system and renin angiotensin system play roles (Marunaka et al., 2017). Quercetin is thought to reduce blood pressure by reducing oxidative stress, by acting on the renin-angiotensin-aldosterone system (RAAS) and improving vascular function (Larson, Symons, & Jalili, 2012).

Evidences for the cardioprotective effects of white tea are still not enough. Nevertheless; white tea is estimated to be beneficial against cardiovascular diseases, for the reason of being richer in terms of catechins and other polyphenols than other teas and that these compounds have significant cardioprotective roles.

1.6. Antidiabetic effects

Several extracts obtained from plants have been reported to be effective in reducing glycemia (Sohn et al., 2010). There are also some evidences which show that tea is a hypoglycemic agent (Mackenzie, Leary, & Brooks, 2007). *In vitro* studies on rats show that EGCG, other catechins and theaflavins help prevent hyperglycemia by inhibiting damage to β-cells and increasing insulin activity (Anderson & Polansky, 2002). In another study of diabetic rats, EGCG supplementation was found to reduce serum glucose, total cholesterol, triglyceride and LDL-cholesterol levels (Roghani & Baluchnejadmojarad, 2010). In a further study, it was determined that prediabetic rats drinking white tea for two months showed lower glucose intolerance and higher insulin sensitivity. Even when compared to non-prediabetic rats, these animals showed only increasingly alanine and acetate and protein oxidation. Although it is needed further study on consumption of white tea to confirm further, preventive effects on DM and in particular diabetic cardiovascular development, it has been suggested that consumption of WTEA may be a standard recommendation for those developing DM or having a risk of developing the disease (Alves et al., 2015). It has also been seen that consumption of white tea in prediabetes rats provides protection of germ cell energetic materials to preserve the content of lactate and alanine under normal levels of testicular metabolism. It has been reported that the results strengthen the importance of glucose tolerance against prediabetes for male fertility and that daily consumption of WTEA may be a cheap and viable strategy to counter metabolic dysfunction caused by prediabetes. (Dias et al., 2016). It is also known that consumption of white tea has an important effect in preventing testicular oxidative damage in prediabetic rats. (Oliveira et al. 2015). In another study, the methanol fraction of white tea ethanol extracts was found to be more active in inhibiting DPP IV enzyme from blood serum. (Ekayanti, Sauriasari, & Elya, 2018). Recently, it has been reported that white tea has strong lipolytic and anti-adipogenic effects *in vitro* studies. (Söhle et al., 2009). Therefore, white tea can exhibit antidiabetic activity by reducing insulin resistance, followed by hyperlipidemia and oxidative stress. (Islam, 2011).

1.7. Anticarcinogenic and antimutagenic activities

In cancer pathogenesis, there are many factors such as genetic mutations, smoking, heavy metal intake and malnutrition. Polyphenols found in tea play an important role in preventing cancer by reducing DNA damage in the cell and reducing cancer activity. (Sharangi, 2009). Plant polyphenols, such as Epigallocatechingallate (EGCG), are the most abundant with strong antioxidant activities in white tea and are responsible for most cancer chemopreventive agents (Haghparasti & Shahri, 2018). In the cell, lipoxygenase and hyaluronidase enzyme inhibition are used to test anti-inflammatory effects of polyphenols. Tea polyphenols ((+) - catechins, 5-o-caffeoylquinic acid (chlorogenic acid), quercetin, rutin) inhibit lipoxygenase and hyaluronidase enzymes (Vieira et al.,2016). Many studies have indicated that tea and its components, especially EGCG, are anti-mutagenic and anti-inflammatory by interfering in carcinogenic substances and reducing oxidant species before damaging DNA (Halder & Bhaduri, 1998; Mitscher et al., 1997; Yang & Wang, 1993). Catechins also protect cell membranes against oxidation and block cell membrane receptors required for cancer cell growth (Bushman, 1998). Catechins possess antimutagenic activity, avoiding the formation of mutagens (i.e., nitrosamines) or preventing the expression of mutagenicity (i.e., polycyclic aromatic hydrocarbons) (Pastoriza, Mesías, Cabrera, & Rufián-Henares, 2017). In animal models tea polyphenols have been shown to inhibit angiogenesis, metastasis and cell proliferation. (Sharangi, 2009). In a study of researching white tea effects on human colorectal adenocarcinoma cells, it has been found that white tea has antioxidant and antiproliferative effects against cancer cells, and has also been found to protect healthy cells against DNA damage. According to the study, there is a significant correlation between the high antioxidant activities and the phenolic content of white tea. It has been reported that regular consumption of white tea may be effective in protecting the health and the body against diseases (Hajiaghaalipour, Kanthimathi, Sanusi, & Rajarajeswaran, 2015). To date, there are few studies on the anticarcinogenic potency of white tea. But recently it has been shown that white tea has chemopreventive and antineoplastic effects in lung cancer cells and protects human skin from ultraviolet rays (Camouse et al., 2009; Mao et al., 2010). It has been reported that longtime consumption of white tea protects against acute oxidative stress when it has no effect on chronic oxidative agents such as aging (Ruiz, Cabrera, López-Jiménez, Zamora, & Pérez-Llamas, 2018). In a study conducted, a simple and one-step process was developed to synthesise developed palladium nanoparticles PdNPs using the Camellia sinensis extract obtained from unfermented young tea leaves or unopened buds. According to the result of the study, it has been reported that, palladium nanoparticles using white tea NPs have strong radical scavenging abilities, antibacterial properties and are antiproliferative to human leukemia cells without affecting normal human fibroblast cells in reverse (Azizi et al., 2017).

1.8. Neuroprotective effect

Oxidative stress, which increases reactive oxygen and nitrogen species in the central nervous system, is an important mechanism for neuronal dysfunction and cell loss in different neurodegenerative disorders. Because of the high oxygen usage, the high content of oxidizable polyunsaturated fatty acids (PUFAs) and the presence of redox-active metals such as Cu, Fe, the brain is particularly vulnerable to oxidative damage (Valko et al., 2007). Oxidative stress, is one of the most important factors that cause neurodegenerative diseases such as Alzheimer, Parkinson, etc. (Halliwell, 2006; Wang & Michaelis, 2010). Antioxidants in foods can increase the antioxidant capacity of the organism to prevent reactive oxygen and nitrogen species and neurodegenerative diseases related to other oxidative damage-inducing materials. (López & Calvo, 2011). This neuroprotective effect is proceeded from the high polyphenolic contents of tea, mainly from catechins and other flavanols. (Almajano et al., 2008; Khan & Mukhtar, 2007; Mandel, Amit, Reznichenko, Weinreb, & Youdim, 2006). EGCG has been shown to have neuroprotective activity in a rat model with Parkinson's disease. (Levites, Weinreb, Maor, Youdim, & Mandel, 2001). In an another epidemiological study, consumption of 2 cups of tea per day has been shown to reduce the risk of Parkinson's disease. (Checkoway et al., 2002). Almajano et al. suggest that consumption of white tea may have positive effects on neuronal cells to reduce oxidative stress related with age-related brain disorders. (Almajano, Vila, & Ginés, 2011).

1.9. Antimicrobial properties

Tea has some antimicrobial properties due to the polyphenols it contains. The antimicrobial activity of the unfermented tea is higher than the fermented or semi-fermented tea. In addition, high antimicrobial activity is found in the tea which has high total polyphenol concentration and antioxidant activity (Nazer, Kobilinsky, Tholozan, & Dubois-Brissonnet, 2005). Because of having them more antioxidant activity, EGCG and EGC are the major components responsible for antimicrobial activity (Gramza & Korczak, 2005). It has been reported that EGCG and EGC inactivate the retrovirus that disrupts the human immune system by inhibiting the transcriptase enzyme which allows the virus to form in host cells. (Yamamoto, Juneja, & Kim, 1997). In a study conducted, antioxidant and antimicrobial properties of black, green and white tea were examined and the total phenolic substance was detected highest in white tea. However, the highest antifungal activity was found in black tea (fermented), followed by green tea and white tea. It has been reported that there is no direct relationship between antifungal activity and total phenol concentration (Camargo, Pedroso, Vendrame, Mainardes, & Khalil, 2016). As a result of an another study on antifungal acitivity has shown that white and black tea can be combined potentially with amphotericin B to increase antifungal activity and thus can be used to decrease side effects of amphotericin B at lower doses (Oliveira, Khalil, & Carraro, 2018).

1.10. Anti-obesity potential

In some studies, it has been shown that intake of tea catechins with regular exercise reduces obesity (Sharangi, 2009). Mechanisms of action of tea in obesity are; stimulation of hepatic lipid metabolism (Murase, Nagasawa, Suzuki, Hase, & Tokimitsu, 2002), lipase inhibition (Chantre & Lairon, 2002), thermogenesis induction (Chantre & Lairon, 2002; Dulloo, Seydoux, Girardier, Chantre, & Vandermander, 2000), appetite regulation (Liao, 2001) and synergism wtih caffeine (Kovacs, Lejeune, Nijs, & Westerterp-Plantenga, 2004). In laboratory studies using animal models, green tea has been shown to be largely obesity-inhibiting, but the effectiveness of white tea has been under-researched. Söhle et al. have reported that white tea inhibits adipogenesis and stimulates lipolysis activity. (Söhle et al., 2009). Studies on rats have been reported to suppress nutrient intake in rats, decrease insulin concentration, cause a significant increase in corticosterone level, affect nutrient intake by changing neurotransmission of dopamine and serotonin in the brain (Sayama, Lin, Zheng, Oguni, 2000; Kumagai et al., 2008). However, the role of tea polyphenols, especially white tea in the prevention of obesity has not been fully elucidated.

Drinking a large volume of OT may dilute gastric juices, increase the work load of the digestive system, slow down digestion, and subsequently may cause gastritis, indigestion, bloating, abdominal pain, and possibly duodenal ulcer (Li, 2015).

2. Conclusions and recommendations

However, there is a need for further studies on the level of consumption necessary to see these health benefits. Polyphenols in tea, have been shown to be effective on human health through studies. There are some considerations that white tea, which has a high content of polyphenols, may be beneficial because of this property. Recent findings indicate that the protective effect of white tea against oxidative stress, which is effective in the pathology of various human diseases, may be responsible for many of the potential health benefits However, further studies are needed on the amount of consumption that can provide health effects.

In order to improve the consumer protection, EFSA has also suggested further studies about the effects of tea catechins and extracts. Experts also want tea products (especially food supplements) to be labeled more clearly in terms of catechin content and possible health risks.

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