Oolong Tea: Biochemical Properties and Health Benefits: A Review

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ABSTRACT

The world's oldest and most widely consumed non-alcoholic caffeine-containing beverage is tea, a traditional Chinese brew manufactured from the dried leaves of the *Camellia sinensis* plant. Based on the oxidation process, there are three primary types of tea made from the *Camellia sinensis* plant: green tea, oolong tea and black tea. Monomeric and oligomeric catechins can be present in oolong tea. Oolong tea contains the highest concentrations of (-)-epigallocatechin (EGC) among white, green, black and Puer teas while green tea contains the highest concentrations of total catechins, (-)-epicatechin gallate (ECG) and (-)-epigallocatechin gallate (EGCG). Various studies show that Oolong tea and other types of tea process assorted pharmacological properties to promote general health. Different *in-vivo* and *in-vitro* research explained that bioactive compounds of tea found to be anticariogenic, anti-microbial, anti-inflammatory, cardiovascular disease, cancer, obesity, anti-oxidant *etc.* can be used as an effective preventive agent for common diseases. Oolong tea has unique polyphenol which is considered as source of healing and effective health-protecting substance. Oolong tea is effective in the control of body weight and fat oxidation of men. The present review will focus on major beneficial effects of Oolong tea, focusing on polyphenol, free radical scavenging, (-) -epigallocatechin *etc.*

Key words: Antioxidant, Non-oxidized, Oolong tea, Partially oxidized, Polyphenols.

The production of oolong a traditional Chinese tea made from the *Camellia sinensis* plant, is a complex procedure that includes withering in the hot sun, oxidation and curling and twisting (Fanaro *et al.,* 2012). Depending on the species and method of production, the level of fermentation varies range from 8% to 85% (Hicks *et al.,* 1996). Oolong tea is mostly produced in the Chinese provinces of Fujian, Guangdong and Taiwan. South Chinese tea experts particularly enjoy this variety of tea (Zhang and Du, 2015). Semi-oxidized oolong teas are commonly referred to as qngchá in Chinese tea culture (Fanaro *et al.,* 2012). Oolong's flavour varies widely among its many sub-varieties. Depending on the horticulture and manufacturing methods, it can have a variety of flavours, including sweet and fruity with honey aromas, strong and woodsy with roasted aromas, green and fresh with bouquet flavours and so on. Nearly 30 countries currently manufacture 70% black tea, 25% green tea and the remaining 5% is made up of oolong tea (FAO, 2010; Rahman, 2014). Oolong tea is consumed in less than 2% of the world's population due to its limited exposure. Every plant has its unique habitat of growing condition. Oolong tea plant is no exception. Suitable soil and climate not only influence the yield but also quality of made tea. Oolong tea prefers warm climate with a temperature range of approximately 10-30°C not adapt well to excessively hot or cold places. Places with 1,000 to 1,250 mm annual rainfall are ideal for growing oolong tea. It grows best in red yellow soil with pH 4.5-6.5 (Chen and Lin, 2014).

It is well known that the chemical constituents of tea, such as volatile compounds contributing to the property of aroma and nonvolatile compounds contributing to the flavour, play a major role in determining its flavour (Scharbert and Hofmann, 2005). Since at least 4,000 BC, tea has been consumed as a nutritious beverage all throughout the world. Taiwan and Fujian in China, as well as Guangdong, produce the majority of the world's oolong tea, which has a flavour and appearance that lies between green and black teas. Young leaves are freshly harvested and allowed to undergo a semi-fermentation process in order to produce oolong tea, where the term "fermentation" refers to natural browning. These reactions are caused by oxidative enzymes that are found in the leaf cells, which cause browning (Lin *et al.,* 2003). The degree of fermentation, which typically ranges from 20 to 80% depending on the appetite of consumers, is realistically managed throughout the manufacturing of the tea. Local manufacturers have experimented with a variety of process conditions to

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produce different products of oolong tea over the past few decades, in response to the expanding market and the demand for quality improvement.

Old oolong tea is traditionally the designation given to oolong teas that have been dried professionally and kept for more than five years (Ying *et al.,* 2013). It is generally accepted that oolong tea improves in flavour and has positive effects on human health as it oxidizes more and more over time (Lin and Chen, 2012). A significant variety of ancient oolong tea that is widely consumed in Taiwan uses periodic baking refinement at least once per year during the ageing process. The two main techniques for regulating the quality of ancient oolong teas are widely recognized as ageing and baking. As can be predicted, various ageing and baking techniques have resulted in the commercial manufacture of a variety of old oolong teas with unique tastes and various physiological effects (Ying *et al.,* 2013).

Since at least 4,000 BC, tea has been enjoyed as a nutritious beverage all throughout the world. The flavour and health benefits of both green and black teas can be found in oolong tea, a partially fermented tea. A significant amount of antioxidants are included in it, protecting healthy skin cells and slowing the ageing process (Sharangi, 2009). Science is beginning to support the Chinese idea that drinking tea helps one live a long and healthy life (Ying *et al.,* 2013). Oolong tea is one of three varieties of tea made from tea leaves, along with black and green teas. While black tea, which is preferred in western nations, is fermented to provide the distinctive flavour components. Green tea which is primarily consumed in Asia, is processed to limit fermentation. Compared to black tea, oolong tea is less fermented. It is frequently offered at Chinese restaurants and is available for purchase commercially in the US. Oolong tea is good at regulating energy metabolism and body weight. The processes in oolong tea can be generally classified into seven steps, sunning and withering, fermenting, panning, rolling, firing, final-firing and packing (Chen and Lin, 2014; Roberts, 1958; Varnam and Sutherland, 1994). Oolong tea, a semi-fermented tea that is particularly beneficial for digestion, is suggested to drink after a substantial meal. Semi-fermented oolong tea has chemical profiles that fall between those of unfermented green tea and fully fermented black tea. To ensure higher quality and vital components in teas, the best matured tea leaves are periodically harvested for processing into green and oolong tea. Desirable nutritional profiles, such as caffeine, polyphenol, fat and protein, are in charge of preserving improved human health. Oolong tea has historically been assumed to offer anti-obesity and hypolipidemic properties. It has also been believed that routine consumption is useful in boosting metabolic rates and fat burning. It has a number of contributing factors, including stress environment (Ying *et al.,* 2013).

The quality of tea depends on leaf processing and manufacturing methods. The degree of oxidation (Huang *et al.*, 2008; Wu, 2011) and oxidation process (Cheng, 2008) both directly affect the characteristics of the final product. The degree of oxidation can be up to 90%, depending on the variety and production style (Xue, 2003). Tea component may vary in the different aged plucked tea leaves.

Essential oolong tea components

Oolong tea contains several different chemical compounds (Table 1) that can improve human health and treat illness. The chemical composition of tea is complex and comprises polyphenols, alkaloids (such as caffeine, theophylline and theobromine), amino acids, carbohydrates, proteins, chlorophyll, volatile compounds, minerals, trace elements and other undiscovered components. The majority of them are polyphenols, which are the primary bioactive compounds in tea (Cabrera *et al.,* 2003).

Major groups are

Alkaloids

Theobromine, caffeine and theophylline (Yi *et al.,* 2015 and Chen *et al.,* 2003).

Polyphenols (PPs)

Catechins, tannins, flavonols and flavonol *glycosides*.

Major catechins

Epigallocatechine, (-)-epicatechine, (-)-epigallocatechin gallate, (-)-epicatechin gallate, (-)-gallocatachine, (+)-catechine, (-)-gallocatechin gallate, (-)-catechin gallate (Yi *et al.,* 2015 and Theppakorn *et al.,* 2014) (-)-Epigallocatechin 3-O-(3-O-methyl) gallate (Zhang *et al.,* 2014, Fei *et al.,* 2014) (Table 2).

Free amino acids

L-theanine, the highest content amino acid in oolong tea (Helen Ekborg-ott *et al.,* 1997; Horanni and Engelhardt, 2013; Türközü and Şanlier, 2017).

Organic acids

Gallic acid, glutamic acid, quinic acid, 5-galloylquinic acid, 5-caffeoylquinic acid, 3-p-coumaroylquinic acid, 4-p-coumaroylquinic acid, 5-p-coumaroylquinic acid and strictinin (Dou *et al.,* 2007).

Non-metals: Fluorine (F) (Chen *et al.,* 2011)

Proteins and complex sugars-oligosaccharides or polysaccharides. (Chen 2011, Stanway, 2013).

Vitamins

Vitamin U, hydrophilic vitamin B, C as well as hydrophobic vitamin A, E and K (Gou, 2005).

Tea polysaccharides

It is a water-soluble polysaccharide *i.e.*

Monosaccharides-D-rhamnose, L-arabinose, D-galactose and D-glucose (Chen *et al.,* 2009; Jiang and Xiao, 2015).

Water extract

Water extract ranged from 263 to 398 mg g^{-1}. Amount in water soluble compounds in Oolong tea are presented in Table 3.

Volatile compounds

Geranyl 6-O-β-xylopyranosyl-β-D-glucopyranoside. (S)-linalyl (76), 2-phenylethyl, benzyl disaccharide glycosides, trans- (79) and cis-linalool 3,6-oxide 6-O-β-D-xylopyranosyl-β-D-glucopyranosides were identified as aroma precursors from oolong tea (Guo *et al.,* 1994; Ogawa *et al.,* 1997). In addition, nerolidol, β-farnesene, linalool, β-ionone, jasmine lactone, indole and some oxidized forms, namely dihydroactinidiolide, geranylacetone, hexanoic acid-3-hexene ester, geraniol, β-decalactone and methyl jasmonate, were identified by gas chromatography-mass spectrometry (GC-MS) (Lin *et al.,* 2022).

Minerals

Used inductively coupled plasma atomic emission spectroscopy (ICP-AES) to analyse oolong tea samples and have found aluminum (Al), barium (Ba), calcium (Ca), copper (Cu), iron (Fe), kalium (K), magnesium (Mg), manganese (Mn), sodium (Na), strontium (Sr), titanium (Ti) and zinc (Zn) in oolong tea (Herrador, 2001). The levels of EGCG and total catechins in different manufactured teas were in the order green tea > oolong tea > fresh tea leaf > black tea, but the levels of caffeine in different manufactured teas were in the order black tea > oolong tea > green tea > fresh tea leaf. This observation was made by compared caffeine and catechins in the same tea but manufactured by different fermentation processes (Cabrera *et al.,* 2003). Another type of polyphenolic compounds called TFs and TRs can also be found in oolong and black teas (Ölmez and Yilmaz, 2009). Oolong (semi-fermented) tea, which was halfway between green and black tea, did not include considerable quantities of the main antioxidant gallocatechins or theaflavins and thearubigins, which are present in fully fermented tea). As a result, this variety of tea possessed antioxidant properties that fell between those of green and black tea. Oolong tea is produced by partially oxidizing the leaf, a step between the production of green and black tea. On the other hand, oolong tea was low in polyphenols and the findings are consistent with discovered that oolong tea had less acquired flavonoid than black tea (Cabrera *et al.,* 2003). In light fermented oolong tea, the TF level was either very low or nonexistent. Due to the low cell breaking rate (about 30%), even in heavily fermented oolong tea, the TFs concentration was only one eighth that of black tea. However thearubigins (TRs) contents formed *via* oxidation of EGC and its gallate. In addition some of the secondary polyphenolic compounds such as oolonghomobisflavane, to the theasinensin and oolongotheanine were formed. Oolong tea has been found to contain four carotenoids, including -carotene, -carotene, xanthophylls and antheraxanthin. Carotenoids break down into a variety of volatile chemicals during processing, underscoring their role in the tea's aromatic flavour. There are fewer carotenoids since some violaxanthan is also transformed to auroxanthin. Less ascorbic acid is present in black and oolong teas than in green tea (Takayanagi, 1977). Compared to black tea, the TF's concentration was just one eighth as high.

Tea catechins were important constituent of oolong tea infusion and total catechin ranged with an average of 86.84 mg g^{-1} in chineese oolong tea. Five catechins and catechingallates *i.e.*

(+) catechin (C), (-) epicatechin (EC), (-) epicatechin gallate (ECG), (-) epigallocatechin (EGC) and (-) epigallocatechin gallate have been detected as the major phenolic compound. EGCG was the predominant species of catechins followed by EGC and ECG. Water extract ranged from 263 to 398 mg g^{-1} and the caffeine ranged from 16.85 to 37.96 mg g^{-1}. Department of Nutritional Services report

Table 1: Components of oolong tea (Sajilata *et al.,* 2008).

Compounds	Contents (mg/100 mL)
Catechins	1.65
Gallocatachine	6.68
Epigallocatechine	16.14
Epicatechine	5.08
Catechin gallate	0.6
Epigallocatechin gallate	5.73
Epicatechin gallate	25.73
Allocatechin gallate	1.85
Gallic acid	2.19
Caffeine	23.51
Polymerized	33.65
Total polyphenols	99.32

Table 2: Components of caffeine and oolong tea polyphenols (Sajilata *et al.,* 2008).

Components	Oolong tea (mg/100 ml)
Gallic acid	2.19
Caffeine	23.51
Gallocatechine	6.68
Epigallocatechine	16.14
Catecchine	1.65
Epicatechine	5.08
Epigallocatechine gallate	25.73
Allocatechine gallate	1.85
Epicatechine gallate	5.73
Catechine gallate	0.6
Polymerized components	33.65
Total polyphenols	99.32

Table 3: Amount of water soluble compounds in oolong tea (Sajilata *et al.,* 2008).

Water soluble compounds	$mg.g^{-1}$
Catechins	34.45-127.99
Caffeine	16.85-37.96
Polyphenols	80.24-168.92
Amino acids	1.77-23.92
Water extracts	263-398

provides that contents of caffeine ranges from 12 to 55 mg for a cup of tea made with loose leaves oolong tea.

Oolong tea polyphenols: unique in characteristics

Oolong tea is an intermediate between green and black teas; oolong tea is characterized by a much shorter fermentation time under moderate conditions such that partial oxidation, rather than total fermentation, occurs. Moderate oxidation apparently creates its own unique set of aroma and polyphenolic compounds. The mechanism of theaflavin formation is the process of intensive oxidation of the catechins. Theasinensins A-E, a class of compounds sometimes known as the bisflavonols, is instances of dead end condensation products since they cannot mechanically progress to the theaflavins. Quinone is low. It makes more sense that, at low quinone concentrations, the quinone reacts with an unoxidized polyphenol and undergoes additional oxidation to form theaflavin. If the quinones are present in sufficient numbers, theaflavins can be produced directly from them, although this process may be stopped. The production of theaflavin may therefore result in the theasinensins (Liang *et al.,* 2003 and Lin and Lin, 1997).

A. Oolongtheanin and Theasinensins

Oolongtheanin and theasinensins F and G, which may be particular by products of the oolong tea fermentation system. The identical condensation product's theasinensins A/B and D/E are atropisomers of the biphenyl link (the gallocatechins). Of one of these theasinensins, oolongtheanin is most likely an additional oxidized version. It is noteworthy, however, that theasinensins F and G were shown to be atropisomers of a mixed condensation of epicatechin gallate and epigallocatechin gallate. A combination of epicatechin and epigallocatechin is anticipated to result in theaflavin digallate. Eight-ascorbyl EGCG (FAO, 2010), an EGCG derivative of vitamin C, two oolong homo bis flavans and oolongtheanin are also present (Hashimoto *et al.,* 1989 and Harbowy *et al.,* 1997).

It is problematic at this time to place oolong tea polyphenols as either unique polyphenols of the divergent path of oolong tea production or as intermediates on the path between green and black tea, with green representing the unfermented leaf and black tea representing either complete or near-complete fermentation.

Manufacturing of oolong tea

The steps involved in creating semi-fermented oolong tea are indoor/solar withering, panning, rolling and drying. Aged tea leaves were picked and then thinly spread out on a flat bamboo basket to wither in the sun for 30 to 60 minutes. Depending on the amount of sunlight, the withering process takes a different amount of time. After that, tea leaves were moved to a floor with shade so they could continue to wither for 6-8 hours and they were stirred by hand every hour. As the moisture level gradually decreases during this process (moisture content below 7 per cent), the border of the tea leaves turns crimson and emits a potent aroma. The enzymes for fermentation were then rendered inactive by drying the withered leaves. It is prepared from mature tea leaves and is partially fermented and semi (15-80%) oxidized.

(1) Oolong tea, which has a 20% fermentation rate. Prior to further indoor withering for three hours at ambient temperature, fresh leaves were first withered by sun light for 30 minutes at ambient temperature. Once the necessary level of fermentation (20%) was reached, the leaves underwent a mass breaking stage of fermentation. In accordance with the instructions for making green tea, the fermented leaves underwent four steps of drying (Tamal and Rashed, 2019).

(2) Partially-fermented tea (Oolong tea)-40% fermentation. This semi-fermented tea was processed as described in the 20% fermented tea, except that the mass-breaking stage was held until 40% fermentation was achieved (Rahman *et al.,* 2014).

(3) Partially-fermented tea (Oolong tea)-60% fermentation. This semi-fermented tea was processed as described in the 20% fermented tea, except that the mass-breaking stage was held until 60% fermentation was achieved.

Oolong tea contains a wide range of polyphenolic components and these many nutrients are presumably combined to provide our bodies with considerable benefits. For instance, they work well to eliminate free radicals and lower triglycerides. The contents of amino acids (AA) ranged from 1.77 to 23.92 mg g^{-1}, whereas the contents of polyphenols ranged from 80.24 to 168.92 mg g^{-1}. Another unusual amino acid found almost solely in tea, L-theanine, which has been demonstrated to have calming effects and aid in anxiety reduction, cognitive improvement and concentration, is present in oolong tea. In addition, glutamic acid, praline and histidine were abundant free AAs. Theanine, glutamic acid, arginine and total free AAs all had co-efficient of variance greater than 50%, while water extract, PPs, total catechins and caffeine had co-efficient of variation below 50% (Aruoma *et al.,* 1994).

The health benefits

The relationship between chemicals and health benefits are described below:

Antioxidant activities of oolong tea and Thea sinensins

The FRAP (ferric reducing/antioxidant power) assay has tested that antioxidant value of oolong tea ranged between 233 and 532 mol/g (Benzie and Szeto, 1999). In an *in vivo* study, modest transient increase in human plasma antioxidant capacity was noticed upon oolong tea consumption (Higdon and Frei, 2003). It is observed that oolong tea reduced oxidative stress, especially oxidative DNA damage (Higdon and Frei, 2003). Furthermore, human studies on athletes showed that oolong tea ingestion significantly reduced plasma malondialdehyde levels in rest and post-exhaustive exercise athletes, as well as resting levels of superoxide dismutase activity, suggesting that the decrease of oxidative stress is resulted from reduction of the lipid peroxidation level and its free radical scavenging activity.

Reduces obesity/natural weight loss and controls diabetes

Obesity is characterized as an abnormally large amount of fat stored in adipose tissue leading to a significant increase in body weight, which has caused public health problems worldwide. Excess energy intake and reduced energy expenditure might lead to abnormal excessive growth of adipose tissue and even result in obesity (Yang *et al.,* 2015).

Oolong tea bioactive ingredients could effectively reduce obesity and control diabetes (Wang *et al.,* 2022). Research reports that polymerized polyphenols (OTPP) from oolong tea extract inhibit pancreatic lipase. Oolong tea is good at reducing weight naturally. You can lose weight by managing your energy intake and output ratios. According to certain studies, supplementing non-obese people with oolong tea (which has an EGCG level similar to that of C) led to a statistically significant reduction in their body fat mass compared to when they received green tea (C content higher than EGCG). Oolong tea extract (OTE) consumption results in increased calorie burning, which promotes fat oxidation and promotes weight loss naturally (Bajerska *et al.,* 2010). It's possible that consuming OTE will help a person maintain a lower body fat percentage. Oolong tea encourages weight loss *via* raising energy expenditure (EE). EGCG in the oolong tea served to our subjects. Catechins have a wide variety of metabolic actions (Kao *et al.,* 2000, Dulloo *et al.,* 2000). They have been related to a decrease in the turnover of norepinephrine.

Now while weight loss seems to be the most common benefit associated with oolong tea that I have come across, the above list gives us more insight. Oolong tea, like green tea, contains calorie-burning catechin polyphenols that, when combined with sensible eating and exercise, can aid in weight loss. Studies have demonstrated that this tea aids in the management of obesity by promoting thermogenesis, the act of the body heating up, which leads to more fat oxidation. In less than a month, drinking three cups each day can provide obvious improvements (Kempler *et al.,* 1977; Sharma *et al.,* 2007; He *et al.,* 2009).

Oolong tea may reduce body weight also *via* inhibition of pancreatic |-amylase activity (Fei *et al.,* 2014). As a major oolong tea ingredient, theasinensin A (TSA) showed anti hyper glycemic and hypo tri acylglycerolemic effects *via* a decrease of serum tri acyl-glycerol (Miyata *et al.,* 2013). Hyperglycemia, the excessive amount of glucose circulating in blood, is considered to be the hallmark in diabetes. Oolong tea was effective in lowering plasma glucose levels of subjects with type 2 diabetes and was even more effective when conjugated with antihyperglycemic agents (Zhang *et al.,* 2019).

Anticaries effect of tea

Tea has anticaries characteristics. Oolong tea extract (OTE) has been found to possess compounds, particularly polyphenols that have antibacterial activity against oral pathogens including *Streptococcus mutans*, the bacteria often connected with dental caries. A diet supplemented with green tea, according to some research, may help manage tooth caries. Numerous mouth rinses with a black tea infusion may improve oral health by reducing plaque's acidity and cariogenic microorganisms, according to certain research (Ooshima *et al.,* 1994, Sakanaka *et al.,* 1996). Tea-leaf-derived catechins have been theorized to have a variety of pharmacological effects. Among these, catechins' anti-carcinogenicity has been effectively used to prevent dental caries. OTE's therapeutic value can be applied to the treatment of precancerous lesions in the mouth as well as the prevention of dental caries and periodontal disease. Similar to white and green teas, oolong has a wealth of health advantages. Free radicals, which are known to cause some malignancies and even skin ageing, have been shown to be destroyed by this tea (Hamilton-Miller, 1995; Ferrazzano *et al.,* 2011; Zhang and Kashket, 1998).

Oolong tea is a partially fermented tea and has the flavor and health characteristics of both green and black teas. It contains a high number of antioxidants, which protects healthy skin cells and the aging process slows down.

Anti-cancer effects of oolong tea

Cancer, the uncontrolled cell division, results in the aggregation of cells to form malignant tumors (Pan *et al.,* 2011). The boiling water extracts of oolong tea leaves (1%-2%) were able to induce DNA damage and cleavage, reduced cell growth, proliferation and tumorigenesis in six different breast cancer cell lines (MCF-7, T47D, SKBR3, MDAMB-231, MDA-MB-436 and MDA-MB-468 cells) (Shi, 2018). In human histolytic lymphoma U937 cells, TSA showed strong growth inhibitory effects *via* mitochondrial transmembrane potential (MTP) loss, elevating the production of ROS, as well as mitochondrial cytochrome c

Table 4: Biological effect of oolong tea in human case studies of cancer.

Type of cancer	Biological end point	Effective dose	Reference
Head and neck cancer (HNC)	↓ the risk of HNC	150-450 ml per day	(Huang *et al.,* 2014)
Ovarian cancer	↓ the risk of ovarian cancer	180 ml per day	(Lee *et al.,* 2013)
Esophageal squamous cell carcinoma (ESCC)	↓ the risk of ESCC	>300 units ofcatechins per day	(Chen *et al.,* 2011)
Colorectal cancer	↓ risk of colorectal cancer	Dependent	(Kaewkod *et al.,* 2019)

Table 5: Bioactivity and mechanism oolong tea for health benefit.

Bioactivity	Mechanism/biomarker	References
Antioxidant activity	Antioxidant power, Reducing oxidative DNA damage, Normalizing the cholesterol profiles, reducing lipid peroxidation level and superoxide dismutase activity.	(Benzie and Szeto, 1999; Higdon and Frei, 2003)
Anti-inflammation	Reducing MCP-1 plasma concentration, Reducing MCP-1 gene expression.	Heber *et al.* (2014)
Anti-obesity	Fat cells and a cell-free system consisting of lipid droplets and hormone-sensitive lipase, Reducing plasma lipid Increasing plasma enzyme SOD Weight ratios of liver to epididylmal adipose tissue.	(Han *et al.,* 1999)
Anti-cancer	Elevating pancreatic lipase activity, Suppressing hepatocarcinogenesis, Anti-mutagenic activities Preventing proliferation and invasion of AH109A cells, Inducing apoptosis and cell cycle arrest, Apoptosis by fragmentation of DNA to oligonucleosomal sized fragments Anti-genotoxic abilities (suppressive effects against *umu* gene expression)	(Matsumoto *et al.,* 1996; Hibasami *et al.,* 2000)
Hypoglycemic effect	Inhibition of SGLT1 Response, Enhancing insulin-activity	(Hossain *et al.,* 2002; Anderson and Polansky 2002)
Prevention of heart disease	Decreasing plasma glucose and fructosamine, Decreasing serum and liver lipids, Increasing EE and fat oxidation, Decreasing plasma adiponectin, glucose and hemoglobin A1c levels, Increasing fecal lipid excretion, Increasing energy expenditure and resting energy expenditure	(Shimada *et al.,* 2004; Hsu *et al.,* 2006)
Anti-microbial effect	Inhibition of GTase, Increasing MNIC and MIC, Decrease of growth and survival, Antibacterial activity	(Yam *et al.,* 1997; Yang *et al.,* 2004)

release into cytosol, which consequently induced rapid activation of caspase-9 and caspase-3 (Shi, 2018). Unlike strong growth inhibitory effects against U937 (IC_{50} = 12 μmol/L), TSA were less effective against human acute T cell leukemia Jurkat (Shi, 2018). In SKOV3 cells, the flavonoid fractions from oolong tea infusion showed significant anticancer activities with 62.78% inhibition rates at the dose of 100 μg/Ml (Xue *et al.,* 2018). Case studies with respect to types of cancer, biological end point and effective dose of oolong tea presented in Table 4.

Antibacterial and intestinal microbiota modulating activities

Oolong tea extract had antibacterial activities against *Streptococcus mutans* and S. *sobrinus* (Sasaki *et al.,* 2004). Noteworthy, the antibacterial activities of oolong tea extract were induced by a synergism of monomeric polyphenols, which can easily bind to proteins. TSA in oolong tea as a major bioactive had effectively suppress the *oxacillin* resistance of methicillin resistant *S. aureus* (MRSA) for at least 10 h. Repeated administration of TSA and oxacillin could prolong the effect (Hatano *et al.,* 2003). Besides, oolong tea showed antifungal activity against *C. glabrata* with the MIC value of 0.156 mg/mL (Chen *et al.,* 2015). Overall bioactivity and mechanism oolong tea for health benefit are presented in Table 5.

CONCLUSION

Oolong teas are distinctive because they range in oxidation from 20 to 80%, with some being more akin to black teas than green teas. Oolongs differ in their caffeine concentration, with greener varieties having less caffeine and darker varieties having more. Oolong teas will contain lower levels of catechins than green tea because they have undergone more oxidation, even if catechins are still there. The levels of theaflavin and thearubigin rise despite the fact that catechins are reduced with oxidation. These polyphenols support the body's defence mechanisms against cancer, heart disease, dementia and stroke. Have a cup of oolong tea with or after your next meal as it is also known to help with digestion. Oolong tea can also improve the health of our skin, immune system and metabolism by eliminating free radicals from our blood stream.

Conflict of interest

All authors declared that there is no conflict of interest.

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