International Journal of Pharmacological Research www.ssjournals.com
ISSN: 2277-3312 Journal DOI:10.7439/ijpr

An overview on tea

Verma Ruchi*, Kumar Lalit, KurbaVijaya Bhaskar and Sudhakar G.K.

Manipal College of Pharmaceutical Sciences, Manipal University, Manipal, Karnataka – 576104, India.

Corresponding author*: ruchiverma_farma@yahoo.com

Abstract

This review focuses on types of tea, its processing methods, bioactive compounds which are present in it, health benefits, toxic effects, interaction with drugs and herbs, formulations involving tea polyphenols. Tea has been found to possess various bioactive leads and need of the hour is to characterize these leads for better product development.

Key words: Bioactive leads, Tea, Polyphenols

1. Introduction

Tea is obtained from the leaves of Camellia sinensis (L.)O.Kuntze of family *Theaceae*. Its trade names are Chaye, Cha etc. It wasformerly cultivated in East Asia and today it is produced all over Asia and some places of the Middle East and Africa[1]. According to the Food and Agriculture Organization of the United Nations, world tea production is 3.2 million tons per annum, and India (27.4%), China (24.7%), and Sri Lanka (9.8%) are the main producers[2].

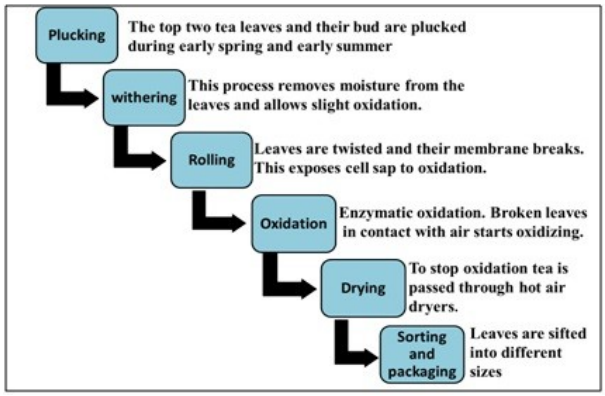
1.2 Types of Tea

There are about 300 various types of tea. Here we have classified few which are mainly consumed based on the process of manufacturing.[3,4]

1. Green tea: It is prepared from mature tea leaves and is non-fermented and non-oxidized.
2. Black tea: It is prepared from mature tea leaves and is fermented and fully oxidized.
3. White tea:It is prepared from tea buds or immature tea leaves and is non-fermented and lightly (15-80%) oxidized.
4. Oolong tea: It is prepared from mature tea leaves and is partially fermented and semi (15-80%) oxidized.
5. Pu-erh tea: It is prepared from tender tea leaves and is post fermented and semi oxidized.

1.3 Tea Processing: Following steps are involved in the manufacturing of tea (Fig.1)[3,5]

Fig.1 Steps in tea processing

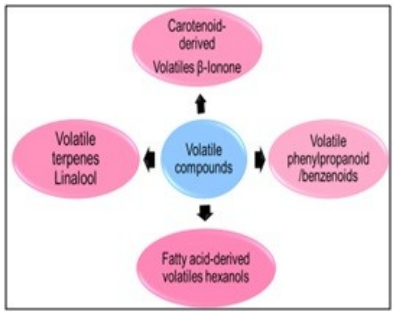


2. Potential bioactive compounds present in tea[6,7,8]

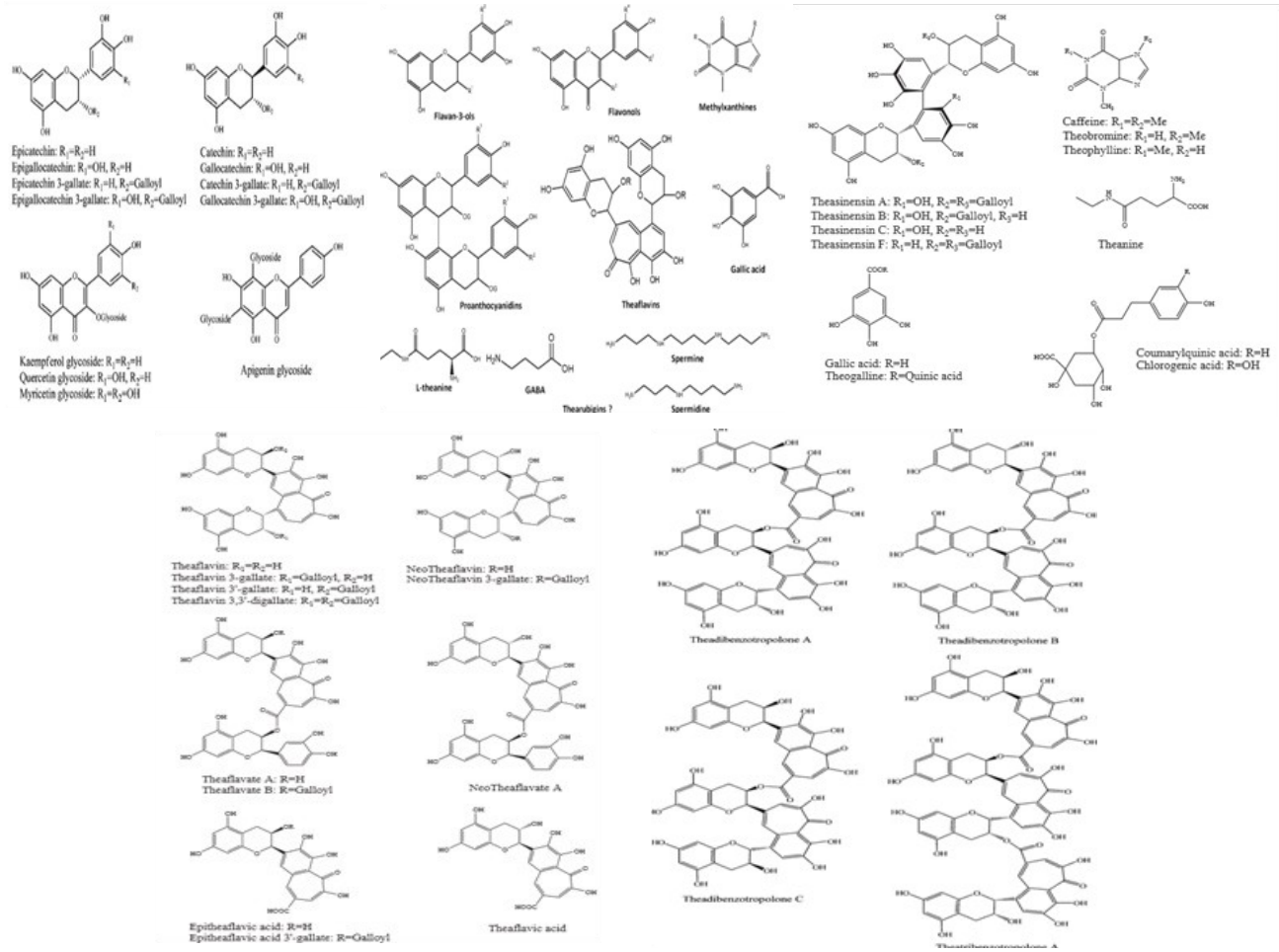
- *Flavan-3-ols*: Flavan-3-ols, catechins, 30% of the dry weight of tea leaves, mainly present in green tea and among them, epigallocatechin 3-gallate (EGCG) is reported as the major compound.
- *Proanthocyanidins* (1-2g/kg): Proanthocyanidins, known as condensed tannins, di- to oligomeric flavan-3-ols in green tea fresh leaves.
- *Flavonols*(3%): Flavonols are present in plants as glycoside derivatives e.g. quercetin, kaempferol, and myricetin attached to sugars such as glucose, galactose and rhamnose.

- *Theaflavins* (2-6%): Includes theaflavin, theaflavin-3-gallate, theaflavin-3′-gallate, and theaflavin-3, 3′-digallate.
- *Thearubigins*: They account for between 30 and 60% of the solids in black tea infusions.
- *L-Theanine and GABA*: L-Theanine and GABA are non-proteic amino acids with amounts reported in white tea being higher.
- *Methylxanthines*: Methylxanthines (e.g. caffeine, theophylline and theobromine) are alkaloids present in tea.
- *Gallic acid*: Gallic acid is a phenolic acid present in tea in different forms, e.g. as the free form, esterified to glucose or to flavan-3-ols. The amounts of gallic acid are comparatively higher in black tea than in green tea.
- *Polyamines*: Polyamines (e.g. spermidine and spermine) are aliphatic polycations derived from L-arginine/L-ornithine and methionine metabolism. It ranges from 63 mg/g in black tea to 123 mg/g in green tea.
- *Vitamins and minerals*: Trace amounts in tea leaves and infusions.
- *Volatile compounds*:(trans-2-hexenal, benzaldehyde, methyl-5-hepten-2-one, methyl salicylate, and indole) that distinguish unfermented teas from fermented ones (Fig.2)

Fig. 2 Volatile compounds present in tea

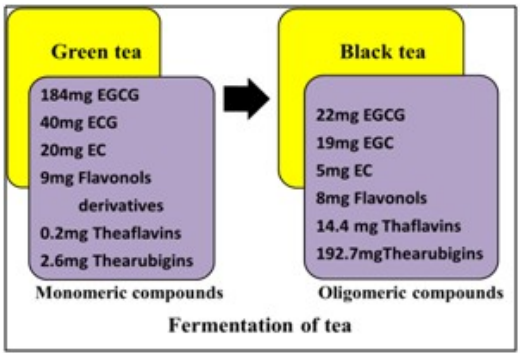


2.1 Structures of chemical constituents present in tea:[4,9]



The constituent percentage depends on the processing of tea. If tea is fermented more the percentage of oligomeric or polymeric compounds increases (Fig. 3)

Fig. 3 fermentation of tea



In a cup of tea green or black when 2g is dissolved in 250 ml of water it contains varying percentages of polyphenols (Fig. 4).

Fig. 4 Content in Tea

3. Health benefits

Tea in various epidemiological studies has proven to be providing various health benefits. Number of *in-vitro* and *in-vivo* data is available related to its potential effects.[10,11,12]

1. Cardiovascular health: Following mechanism have been related to tea whichimproves cardiovascular health.[13]

a. BP lowering.
b. Improved dyslipidemia.
c. Improved insulin sensitivity.
d. Weight loss.
e. Antioxidant.
f. Anti-inflammatory effects.
g. Improved endothelial function.
h. Platelet inhibition.
i. Inhibition of smooth muscle cell
j. Proliferation and migration.

2. Cancer: Tea has been found to be effective in various cancers like skin cancer, Liver cancer, Lung cancer, Gastrointestinal cancer, Pancreatic and bladder cancer, bladder cancer, breast cancer. Proposed mechanisms are binding directly to carcinogens, induction of Phase II enzymes. Molecular mechanisms, including catechin-mediated induction of apoptosis and cell cycle arrest, inhibition of transcription factors NF-κB and AP-1 and reduction of protein tyrosine kinase activity and c-jun mRNA.[14]

3. Weight management: It is possible through the thermogenic and fat oxidation properties of tea.

4. Type II Diabetes: In various studies tea has been found to be useful in reducing the glucose level through the modulations of energy balance, endocrine systems, food intake, lipid and carbohydrate metabolism.

5. Cognitive performance, mental relaxation and neuroprotection: It is possible through varying mechanisms by tea.

- Divalent metal chelating properties
- Antioxidant and anti-inflammatory activities.
- Reduction of ischemia/reperfusion-induced brain injury.
- Modulation of signal transduction pathways, cell survival/death genes and mitochondrial function.[15]

6. Immunity: There is decrease in the incidence of cold and flu as the histamine release from tea has been found to decrease due to tea intake.

7. Dental caries: It shows inhibitory effects on the growth of cariogenic bacteria by inhibiting the adherence and the growth of bacteria *streptococci*, *porphyromonasgingivalis* at the tooth surface and the glucan synthesis by streptococci.

8. Renal effects: Catechins increase the excretion of sodium and prostaglandin E2 and improve the renal circulatory status.

9. Skin and eye protection: Black tea polyphenols protect against ultraviolet induced erythema, tyrosine phosphorylation and inflammation response in mouse and human skin. Green tea polyphenols protects eye lens against photo oxidative stress induced by ultraviolet radiations. EGCG enters the eye,reaches the lens and inactive oxidants induced by UV light exposure. Drinking white tea while watching television protects our eyes from harmful radiations.

10. Anti HIV: Flavonoids in tea inhibit retrovirus human immunodeficiency virus (HIV) proliferation by constraining reverse transcriptase.

11. Antimalarial, Antiviral, Antibacterial, Anti-staphylococcal: It is effective against various gram positive and gram-negative bacterias. It reduces enterobacteria which releases ammonia, amines. Inhibits rotavirus propagation in monkey cell cultureand influenza Avirus in animal cell culture. Through computer aided drug design it has been found that Gallocatecin has smaller energy than mefloquine to bind to lactate dehydrogenase 1CET.[16]

12. Anti-arthritic: Studies shows that people drinking tea has more bone mineral density. There is reduction of inflammatory intermediates which reduces arthritis.

4. Toxic effects

Though tea is related with various health benefits but excessive intake of tea leads to certain toxicities.[17]

Green tea: Hepatotoxicity, Oxidative stress, Mitochondrial toxicity, Side effects such as Headache, Nausea, Muscle pain. The LD50 dose of caffeine in Green Tea is estimated to be 10–14 g (150–200 mg/kg of Green Tea).

Black tea: Precipitation of digestive enzymes, Affects useful microflora of intestine, Reduced iron absorption, Rectum cancer and flouride toxicity.

White tea: Reduced iron absorption by forming insoluble complexes in gastro-intestinal tract.

Oolong tea: Affects functioning of pancreatic lipase, Increased risk of diabetes.Too much of this tea results in osteoporosis by excreting calcium in urine because of its more caffeine content. It should not be taken more than 3 cups a day.

Pu-erh tea: Osteoporesis, Increased blood pressure, Arsenic level high, not advised in pregnant women. It has high caffeine content

Tea and Pregnancy: EGCH can inhibit an enzyme called dihydrofolatereductase (DHFR) can induce folic acid deficiency, causing abnormal neural tube development. Spina bifida may result. Also caffeine present in tea may pass through placenta and produce harmful effects. It increases urine flow also. There are increased risks of miscarriage.

Other side-effects:

- Prostate cancer may result due to excessive intake.
- Hot drinking temperature of tea may degrade teeth enamel.
- Oxalates present in tea may result in kidney stones.
- Aluminium present in tea leaves may produce toxixity.

5. Tea and drug interaction

Following interaction of tea with drugs has been reported. Some of which are listed below:[18]

1. Stimulant drugs: Amphetamines, Ephedrine. As these drugs are stimulating and taking these drugs with tea may further increase the stimulatory activity.[19]

2. Antibiotics (Quinolone antibiotics): ciprofloxacin, enoxacin ,norfloxacin.

3. Medications that slow blood clotting (Antiplatelet /Anticoagulant drugs): Warfarin, Heparin, Aspirin.Tea increases the

chances of bleeding by slowing the action of these drugs.[20]

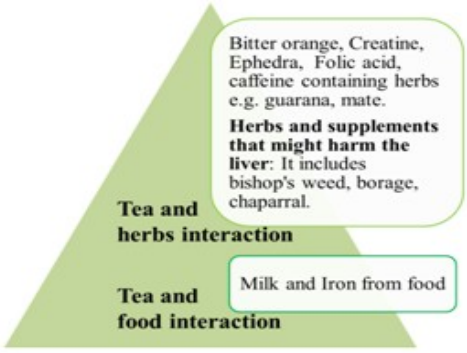
4. Medications used to treat cancer (Boronic acid-based proteasome inhibitors):bortezomib (Velcade). Tea decreases the effectiveness of these drugs.

5. Birth control pills (Contraceptive drugs): ethinylestradiol and levonorgestrel (Triphasil).These drugs decreases the metabolism of caffeine.

6. Medications for asthma (Beta-adrenergic agonists): albuterol (Proventil, Ventolin, terbutaline (Bricanyl), theophylline. Theophylline is a xanthine derivative and these substances also contain xanthine. Hence consuming large amounts of these substances while taking theophylline, increases the risk of drugtoxicity. Additionally, both oral bronchodilators and caffeine stimulate the central nervous system.

7. Medications that can harm the liver (Hepatotoxic drugs): acetaminophen, statins, phenytoin. Green tea has been found to produce hepatotoxicity at large doses, further if take this along with drugs may worsen the condition.

Fig.5 Tea and Herb, Food interaction



6. Formulations

1. Poly(lactic-co-glycolic acid) nanoparticles of tea polyphenols have been prepared to prevent against chemically induced DNA damage.[21]

2. Inhibition of herpes simplex virus type 1 with the modified green tea polyphenol palmitoyl-epigallocatechin gallate.[22]

3. LipophilizedEpigallocatechinGallate (EGCG) Derivatives have been formulated as Novel Antioxidants.[23]

4. Semisynthesis of O-Acyl Derivatives of (−)-Epigallocatechin-3-gallate as Antitumor Agents.Decrease in the antitumor activity was found with the increase in size and branching of the chain length of acyl groups.[24]

Other formulations made from tea extract which are available in market are hair removal wax, fat burner, energy supplement, antioxidant supplement, face cleanser, bathing soap, face mask, baby diapers, sanitary pads, tissue papers, lotion, shampoo, age delay creams, fairness gel, moisturizer, bath foam, toothpaste, quench mask, scrub, energy drink, candies, chewing gum.

7. Conclusion

Polyphenols, theaflavins and catechinshave been found to be biomolecular markers of tea and its extract. Biological mechanisms that are related with a well-characterized chemical profile will provide useful information for product development in targeting specific problems like cardiovascular, cancer, antibacterial etc. Also there is a need for understanding complex structures of thearubigins.

References

1. Sajilata MG, Bajaj RP, Singhal RS: Tea polyphenols as nutraceuticals. *Comprehens Rev Food Sci & Food Saf* 2008; 7: 229-254.
2. Naghma K, Hasan M. Tea polyphenols for health promotion. *Life Sciences*2007; 81:519–533.
3. Karori S M, Wachira FN, Wanyoko JK and Ngure RM. Antioxidant capacity of different types of tea products. *Afr J Biotech* 2007 October, 19: 2287-2296.
4. Norman G, Max W: Herbal drugs and phytopharmaceuticals, A handbook for practices on a scientific basis with reference to German Commision E Monographs. 2nd edition. Germany: medpharm scientific publishers; 2001: 490-

492.

5. http://en.wikipedia.org/wiki/Tea_processing accessed on 10th August 2013.
6. Peterson J, Dwyera J, Bhagwat S, Haytowitz D, Holden J,Eldridge AL, Beecherd G, Aladesanmi J. Major flavonoids in dry tea. *Journal of Food Composition and Analysis*2005; 18: 487–501.
7. Shengmin S, Joshua DL, Chi-Tang H, Chung SY.The chemistry and biotransformation of tea constituents. *Pharmacological Research* 2011; 64: 87– 99.
8. Ziyin Y, Susanne B, Naoharu W. Recent studies of the volatile compounds in tea. *Food Research International*2013; In Press.
9. Susanne MH, Yantao N, Nicolas HL, Gail DT, Rosario RM, Hejing W, Vay L W G, David H. Bioavailability and antioxidant activity of tea flavanols after consumption of green tea, black tea, or a green tea extract supplement. *Am J ClinNutr* 2004; 80: 1558-64.
10. Christiane JD, Edward RF. A review of latest research findings on the health promotion propertiesof tea. *Journal of Nutritional Biochemistry*2001; 12: 404–421.
11. Chung SY, Janelle ML. Effects of Tea Consumption on Nutrition and Health. *J. Nutr.* 2000; 130: 2409–2412.
12. Marcia da SP.Tea: A new perspective on health benefits. *Food Research International*2013; In press.
13. Apranta D, Joseph AV. Tea and cardiovascular disease. *Pharmacological Research*2011; 64: 136– 145.
14. Jian-Min Y, Canlan S, Lesley MB.Tea and cancer prevention: Epidemiological studies. *Pharmacological Research*2011; 64: 123– 135.
15. Yi L, Genguang J, Lingshan G, Lingyan S, Xiaobin F, Nuo L, *et al*. Antidepressant-like effects of tea polyphenols on mouse model of chronicunpredictable mild stress. *Pharmacology, Biochemistry and Behavior* 2013; 104: 27–32.
16. Maulana T, Hari P. Tea leaves extracted as anti-malaria based on moleculardocking PLANTS. *Procedia Environmental Sciences*2013; 17:188 – 194.
17. Jain A, Manghani C, Kohli S, Nigam D, Rani V. Tea and human health: The dark shadows. *Toxicology Letters* 2013; 220(1): 82–87.
18. http://www.nlm.nih.gov/medlineplus/druginfo/natural/960.html accessed on 10th august 2013.
19. Ikeda H, Moriwaki H, Matsubara T, Yukawa M, Iwase Y, Yukawa E. Mechanism of interaction between risperidone and tea catechininfluence of presence of galloyl group in catechin on insoluble complex formation with risperidone.*YakugakuZasshi*. 2012;132(1):145-53.
20. Aspirin and Green Tea drug interactions - a study by eHealthMe.html accessed on 10th august 2013.
21. Amit KS, Priyanka B, Madhulika S, Sanjay M, Pradeep K,Yogeshwer S, Kailash CG.Synthesis of PLGA nanoparticles of tea polyphenols and their strong in vivo protective effect against chemically induced DNA damage.*International Journal of Nanomedicine* 2013; 8: 1451–1462.
22. Aline de O, Sandra DA, Lee HL, Sean RM, Stephen DH, Jeffrey R. HammondcInhibition of herpes simplex virus type 1 with the modified green tea polyphenol palmitoyl-epigallocatechingallate. Food and Chemical Toxicology 2013; 52: 207–215.
23. Ying Z, Fereidoon S. LipophilizedEpigallocatechinGallate (EGCG) Derivativesas Novel Antioxidants.*J. Agric. Food Chem.* 2011; 59 (12): 6526–6533.
24. Sandeep V, Manu S, Pritam DS, Tej VS. Design, Semisynthesis, and Evaluation of O-Acyl Derivatives of (−)-Epigallocatechin-3-gallate as Antitumor Agents.*J. Agric. Food Chem*. 2007; 55 (15): 6319–6324.