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Geography and the therapeutic effect of matcha tea in drinks

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Abstract
Camellia sinensis belonging to family Theaceae, commonly called as tea is the most widely used refreshing beverage accepted globally. It has two variety such as Green tea and black depending upon its method of cultivation. Green teas are non-fermented minimally oxidized variety of tea. Green tea has also attracted the research limelight because of its variety of Phenols with versatile pharmacology and health effects. There are wide range of green tea some are Biluochun, Gunpowder, Genmaicha, Matcha, Sencha. Matcha which commonly originates in Japan and is a type of powdered green tea, cultivated and produced in a traditional way. Shading of the plants during the growth period enhances the processes of accumulation and synthesis of biologically active compounds, including caffeine, theanine, chlorophyll and various types of catechins. Retention of chlorophyll results in soothing green colour of tea and theanine for it non bitter taste. Green tea contains four main catechins, i.e., (−)-epicatechin-3-gallate (ECG), (−)-epicatechin (EC), (−)-epigallocatechin-3-gallate (EGCG) and (−)-epigallocatechin (EGC), of which (−)-epigallocatechin-3-gallate (EGCG) is the most active and is present in abundance and matcha is their best condensed source. Matcha tea is considered as highest quality tea Due to its unique chemical composition and texture, which also sets it apart from other tea beverages. Its high content of antioxidant and anti-inflammatory substances attributes the various health-promoting properties. Due to its potential for preventing many diseases and illness, regular consumption of matcha may have a positive effect on both physical and mental health. The aim of this review was to compile the native origin and health benefits of matcha tea along with its side effects.

Keywords: Matcha, green tea, native origin, cultivation, catechines, EGCG, Camellia sinensis, chemical composition, healthpromoting effect, adverse effects

Introduction
Tea is considered to be the most demanded and most important drink in the world because of its soothing taste and therapeutic effects. Different countries serve tea in a different way. It is distributed widely in the East and the West, from old world to the new world today. Tea production is confined in certain region of the world despite of its wide geographical range of drinking [1]. This is due to the depending of tea tree growth on limited ranges of geographical and climatologically factors. In Japan green tea is considered to be the most consumed tea. Drinking green tea has become more popular in the world which earlier was not so common in the past because of wide range of health benefits [2]. In many societies tea is considered to be the most common beverages after water. Its health promoting effects, flavor and aroma is highly valued around the world [3]. Matcha tea which is also known as Japanese green tea is available in many variants. i.e., in the form of packed tea bags, loose leaves and powdered form [4]. It is rich in antioxidants because of the special cultivation techniques that is used by the cultivators [5]. According the traditional method of cultivation and collection, for the majority of its growth period, Bamboo mats are used to shade the leaves from the direct sunrays [6]. Because of its traditional technique of cultivation, plants are able to produce higher amounts of bioactive compounds and amino acids, including theanine and chlorophyll which is responsible for the unique non bitter taste and soothing colour of matcha [7].

Native origin of green tea
Camellia sinensis (tea tree) is considered to have originated in evergreen forest of the Tibetan plateau on its eastern flank in the present day Guighou and Yunna province of China [8].

Mountain tea tree (Yamacha) is widely distributed in mountains of Western japan. It was found that the Yamacha trees do not exist in evergreen forests are not indigenous to the Islands of Japan [9]. There is no clear report about how these trees came to Japan from the Chinese continent. It is said that Sai Cho a famous monk came back from China with tea tree seeds for approx 1200 year ago [10].

Fig 1: Matcha Tea-A natural drink with antioxidant properties (Olivencia, J.M., Matcha Tea-A natural drink with antioxidant properties)

Geographical and climatological factors required for the cultivation of green tea

As per the report, large scale production of tea tree mainly concentrates in the plateau areas of Kyushu and Honshu Islands of Japan situated in a height of 2,000 m, despite this high altitude this region is warm ad rich in rainfall due to its prevalent monsoon [11]. For the cultivation of tea tree in the areas which is close to the Northern boundary and beyond, frosting can be a severe issue [12]. To avoid this issue in the tea producing area, farmers uses water sprinklers, when water freezes, it emits a large amount of heat. Thus, in a state where ice and water coexist, the temperature does not go below 0 degrees and sprouts do not undergo damage due to extreme cold. Therefore, sprinkling water continuously over the tea tree can protect the sprouts from frosting [13].

Humidity

For the cultivation of tea tree it requires rich moisture in the air as in wet mountain ranges of Guizhou and Yunnan provinces [14]. In China majority of tree producing areas receives annual rainfall of over 1600mm [15].

Soil

For the cultivation of Tea tree it prefers soil of high water infiltration. So as to avoid the degradation of roots due to excessive water. A proper drainage of water is required for its cultivation because tea roots may rot due to the act of O_2. Thus, for its production it requires a soil that quickly dries [16]. The largest tea producing area in Japan is Makinohara Plateau in Shizuoka Prefecture, the plateau consist of the deposits of old uplifted river sediments and a volcanic ash. Hence, both these alluvial soil and volcanic ash is believed to have high infiltration rates, which eventually fastens the process of drying making it suitable for the cultivation of tea tree [17].

Production of matcha tea

Matcha tea is a non-fermented or non-oxidized tea whereas black tea is an oxidized or fermented tea prepared from the similar kind of tea tree as for the green tea. In order to stop the process of fermentation the enzyme present in leaves must be de-activated 18. In Japan to accomplish this task the tea leaves are exposed to steam, whereas in China tea leaves are boiled to de-activate the enzyme. After the tea leaves are exposed to stem it is dried and are massaged which is done in order to make the ingredients exclude easier in the tea liquid. Through this process the tea leaves are produced in needle shape. This particular process of producing green tea was invented by Soven Nagatani of Kyoto in 1738, which is now widely spread in Japan. The taste of green tea can be varied by the alteration of its ingredients through varying cultivation techniques 19. For example, Amino acids teanin provides mild sweetness to green tea. Teanin when exposed to sunlight converts into catechin. Hence, Dark nets are used by the farmers to cover tea trees from the direct sunrays in order to increase the sweetness of green tea 20.

Green tea composition

Due to the fortified benefits of the minerals present in matcha tea. Many studies and research has been conducted on the therapeutic effect of matcha tea [21]. On an average, 3-4% of alkaloid called as methylxanthines, caffeine theophylline and theobromine are present in the fresh leaves [22]. In addition there are amini acids such as theanine and phenolic acid such as gallic acids are also present [23].

Table 1: The chemical composition of green tea is complex

Phytochemical	Type of Phytochemical Constituents
Amino acids	Theanine or 5-N-ethylglutamine; glutamic acid; tryptophan, glycine; serine; aspartic acid; tyrosine; valine; leucine; threonine; arginine and lysine
Carbohydrates	Such as cellulose; pectins; glucose; fructose and sucrose
Minerals and Trace Elements	Such as calcium; magnesium; chromium; manganese; iron; copper; zinc; molybdenum; selenium; sodium; phosphorus; cobalt; strontium; nickel; potassium; fluorine and aluminum
Trace amounts of lipids	Linoleic and α-linolenic acids
Sterols	Stigmasterol
Vitamins	Vitamins A; B_2; B_3;C; E; K
Xanthic	Bases caffeine; theophylline
Pigments	Chlorophyll; carotenoids
Volatile compounds	Aldehydes; alcohols; esters; lactones; hydrocarbons
Phenolic acids	Gallic acid

Therapeutic effects of matcha tea

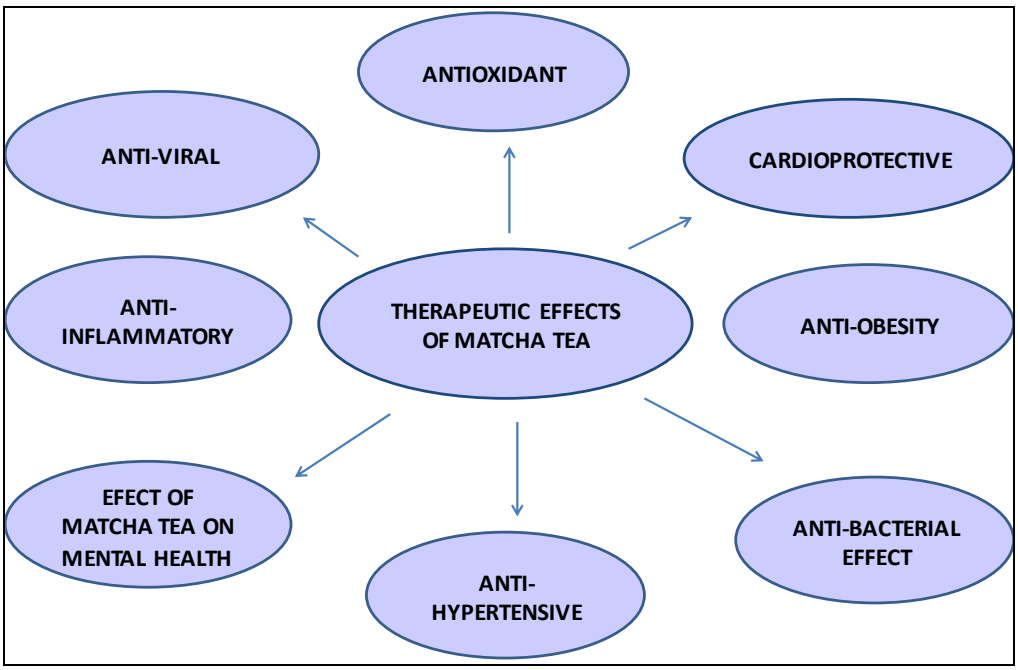

Fig 2: Therapetic Effect of Matcha Tea

1. Antioxidant

The term oxidative stress indicates the imbalance between antioxidant capacity of the body and production of reactive oxygen species (ROS) which causes the damage to the normal and healthy functioning of DNA, lipids and protein which eventually results in affecting the development and occurrence of many chronic diseases [24]. Polyphenols present in Tea which is one of the bioactive compounds, have been proven to render ideal natural anti-oxidants by *in vitro* and *in vivo* experiments. Polysaccharides along with polyphenols in green tea also potential antioxidants which was determined via reducing power, ABTS and DPPH radical scavenging, and oxygen radical absorbance capacity (ORAC) assays as well as improving H_2O_2 induced oxidative injury in human umbilical vein endothelial cells (HUVEC) [25].

2. Inhibits the propagation of cancer stem cells

Breast cancer is one of the leading causes of women's cancers, although a small fraction of men may also be affected 26. Ignorance at its initial stage may turn into cancer which may be lethal 27. A Recent study has suggested that Japanese green tea has antioxidant, chemo-preventive and anti-bacterial activities. The key component of matcha tea, namely epigallocatechin-3-gallate, behaves as an anti-tumor and a potent antioxidant against breast cancer cells [28, 29]. According to the studies the Asian-American women shows decreased risk for developing breast cancer [30].

3. Cardio protective effects

For cardiovascular diseases, cigarette smoking is considered as one of the major risk factors 31. According to the research rats were taken as animal model which was exposed to cigarette smoke along with simultaneous oral administration of EGCG which is the key component of matcha tea. The markers of myocardial injury and lipid anomalies were elevated on exposure to cigarette smoke. These aberrations were reversed on the administration of EGCG. According to the results from the study, it has been observed that the antioxidant EGCG exerts a protective effect on the heart muscles by preventing cardiac inflammatory changes via reducing oxidative stress [32]. The protective effect is exerted by the EGCG on the heart muscles in patients undergoing surgery and is sensitive to ischemic injury. This is successfully achieved by inhibiting the activation of stress-activated protein kinase and signalling pathways inducing the inflammatory response.

4. Anti-obesity

Obesity is a result of unhealthy lifestyle and taking in more calories than burning by exercise or active routine. This is an epidemic disease involving excessive body fat that eventually results in various illnesses such as increasing the incidence of heart disease, diabetes, cancer and hypertension. Obesity is a result of two major factors: mass of adipose tissue and the increased secretion of pathogenetic products from enlarged fat cells [32].

5. Anti-viral effects

Many studies have been carried out on the anti-viral properties of matcha tea. Its anti-viral and immunomodulatory properties may help to regulate immune response and the prevention of infectious diseases [33]. Chen *et al*. (200) carried out the studies on different compounds derived from C. sinensis including Catechins, tannic acid and 3-isotheaflavin-3-gallate.It was found that inhibitory action was not shown by catechins but tannic acid was found to be the potent inhibitors on SAR COVID [34].

6. Anti-hypertensive effect

Hypertension is a chronic Medical condition caused by the elevated blood pressure in the arteries controlled by multiple genes, vascular remodeling and inflammation. Matcha tea contain polyphenols (GrTPs) are rich in antioxidant and are found to promote anti-inflammatory response [35]. According

to a research based on clinical studies, it was found that the daily consumption of Matcha tea (120-599 ml) was found to reduce the chances of hypertension by 46% [36].

7. Anti-inflammatory effect

Studies have shown that extract of matcha tea possess anti-inflammatory effect [37]. The anti-carcinogenic and anti-inflammatory properties of match tea also called as green tea are due to their polyphenols present therein. Green tea polyphenol treatment to skin has been observed to modulate the biochemical pathway involved in cell proliferation, inflammatory responses and ultraviolet (UV) light induced inflammatory markers of skin inflammation [38]. Topical treatment with green tea phenols on mouse skin showed the prevention of oxidative stress and immune suppression induced by UV light. Based on the various beneficial effects of green tea which are documented in many journals, many cosmetic and pharmaceutical companies are using it as one of the ingredients in their skin care products [39].

8. Anti-bacterial effect against *Streptococcus pneumoniae*

Having 1.5g of matcha powder with hot water (70mL) inhibits the growth of resistant pneumococcal and antibiotic-susceptible strains. The used concentration for *in vitro* analysis was 20 mg/mL as the standard, thus the matcha supernatant possess bactericidal activity against S. pneumonia [40].

9. Effect of matcha tea on mental health

Drinking matcha tea has positive effect on mental stability, overall well-being, mind and consciousness. EGCG is a compound present in matcha tea with high antioxidant activity and is able to counteract the increased oxidative stress in the hippocampus and thus restores memory ability and learning by blocking the progressive rise in systolic pressure and enhancing the endothelial functions [41].

Adverse effects of matcha tea

Although the leaves obtained from *Camellia sinensis* which turns out to be matcha tea using a different cultivating pattern has several beneficial and healing effects on health but higher doses may cause some unknown adverse effects. Moreover, the effects of Catechins present in green tea may not be similar in all individuals [42]. A research was carried out on tea leaves and it was found that the higher consumption of matcha tea can exert acute cytotoxicity in liver cells [43]. A study found that the excessive intake of green tea may cause oxidative DNA damage of hamster pancreas and liver [43]. A study found at a high dose (5% of diet for 13 wk) green tea extract caused a thyroid enlargement (goiter) in normal rats [44]. The plasma concentration of the thyroid hormone was modified with the high-level treatment. However, drinking excessive amount of matcha tea would be unlikely to cause the same adverse effects in humans as well. Along with the health benefits of green tea there are many harmful effects as well as the overconsumption of green tea causes various illness to human health.

There are three main factors that cause harmful effects of tea overconsumption;

1. The effect of tea polyphenols on iron bioavailability.
2. The presence of aluminum.
3. Its caffeine content.

Green tea should be avoided by the patients suffering from major cardiovascular problems or heart conditions. Pregnant and lactating women should avoid or drink no more than one or two cups per day because content in green tea can cause increased heart rhythm. As caffeine possesses diuretic effect hence overconsumption of green tea should be avoided, so as to avoid dehydration [45]. Some research revealed that the capacity of tea plant to accumulate high levels of aluminum can result in nephrological diseases as aluminum can be accumulated by the body of patient with renal failure [46]. Therefore, it is necessary to control the intake of food with high amount of aluminum. Also having green tea right after meal decreases the absorption of iron from food Thus, cause a significant decrese in iron content of blood which eventually results in anemia [47].

Conclusion

Green tea is undoubtedly the natural drink of Japan. Tea drinking has been an essential part of daily life for many Japanese people. Matcha tea which is commonly known as green tea is becoming popular in many parts of the world. Matcha tea trees are considered to be originated in evergreen forest distributed widely in the highlands of Yunna and Guizhou province, China and they propagated to Japan**.** Tea producing areas are rich in rainfall and are warm. But excessive water can also rot roots of tea trees. Therefore, on plateaus with high water infiltration its large scale farming is conducted. Soil preferred for the growth of green tea is weak acidic and volcanic ash-derived. Laboratory studies showed various health benefits of green tea, substituting other beverages with matcha tea can treat many health issues like blood pressure, diabetes, fatigue, obesity and various skin diseases by detoxifying blood. But the human clinical evidence of protective benefits of matcha tea is still limited. Thus, development of more sensitive and specific methods with more representative models along with the development of better predictive biomarkers shall give a better understanding of how matcha tea interacts with endogenous system and exogenous factors. A well-designed observational epidemiological studies and intervention trials is to be made to have definitive conclusion concerning the protective health benefits of matcha tea. To facilitate future research I this area, biomarkers for green tea consumption and molecule marker for its biological effects has to be developed in order to get better results.

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