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# Processing and health benefits of matcha – a review

BACHELOR'S THESIS

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# Declaration

I hereby declare that I have done this thesis entitled Processing and health benefits of matcha review independently, all texts in this thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

Date: April 11th, 2022

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Name of student

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## Abstract

Tea is one of the most popular drinks in the world. Green tea provides a variety of nutrients, including polyphenols, amino acids, and some trace elements. Matcha was the first to appear in China, but it is well known from Japan and powdered from green tea leaves. The production process of matcha go through primary processing and refined processing from picking to making. Matcha is rich in Epigallocatechin gallate (EGCG), caffeine and some other elements, which can be used for medical purposes. Matcha is also used for medical treatment in Japan. It can promote mental clarity, improve mood, delay the onset of cancer and so on.



**Key words**: Matcha processing, EGCG (Epigallocatechin gallate), Caffeine, Vitamin C, health promoting effect

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# 1. Introduction

Tea is one of the most popular beverages in the world. The global green tea market is growing, and it is estimated that the output of green tea in 2023 be twice that of 10 years ago[1]. Green tea provides a variety of nutrients, including polyphenols, amino acids and some trace elements[2]. Although matcha and regular green tea come from the same camellia plant, matcha is grown and processed differently. First, during the planting process, green tea grows in the sun. However, matcha grows in the shade during the last few weeks before harvest. Therefore, this different cultivation method lead to an increase in the content of theanine in Matcha green tea, giving it a special taste that can balance the usual bitterness of tea, called "umami." In addition, the processing methods of regular green tea and matcha are also different. When processing ordinary green tea, the process usually includes drying, tumbling and steaming. However, in the processing of matcha green tea, the tea leaves are destemmed and veined, and only steamed shortly after harvest. Therefore, due to this special processing method, the nutrient loss of green tea during the cooking process can be prevented, thereby bringing more health benefits. It can also make matcha green tea a bright green colour. In other words, because catechins usually have a bitter taste, ordinary green tea powder on the market can only contain 0.5 g of tea leaves per serving, otherwise the bitter taste makes it unacceptable. However, the "umami" of matcha derived from theanine weaken the bitterness and increase the palatability, so that each serving of matcha green powder products can contain 1.5 grams of tea leaves. Therefore, due to several special characteristics of matcha green tea, it is recommended to drink the same amount of tea that has a better taste than ordinary green tea, and provides twice the polyphenols and higher fat-soluble nutrients, such as vitamin K and Lutein. Among them, EGCG (Epigallocatechin gallate) is a well-known polyphenol and one of the most abundant catechins in green tea extracts. It has anti-inflammatory and strong antioxidant properties [3][4].

## 2. Aim of the thesis

The purpose of this article is to summarise the specific production process of matcha, and the impact of matcha on the health of customers – both positive and negative. Review the ingredients of matcha tea and the distribution of production areas during the research process.

## 3. Tea Taxonomy

*Camellia* is the largest genus in the Theacae family, with more than 200 species in the world, South and East Asia, North America, Central America and South America[5]. Camellia is mainly distributed in southern China and Southeast Asia, including the north-western Indonesian archipelago and the Philippines. Including parts of Japan and South Korea, this is a geographically and widely distributed area with different climate and geographical conditions[5][6][7].There have always been different opinions on the classification system of *Camellia*. The Sealy (1958) system is divided into 12 groups. According to stamens from many too few, free to different degrees of connate, carpels are not completely merged to merge, styles are separated to different degrees of connate, ovary develops in 5 to 3 or only 1 compartment, relative degree of pedicel, small bud The number of slices, texture and size, etc. are carried out in minutes (system outline of Camellia; Camellia subgenus and a small part of the classification system) [8].

Matcha is made from green tea. Green tea is sourced from *Camellia sinensis* (L.) O. Kuntze (Theaceae), the same species from which white, oolong, black and Pu-erh teas are derived. *Camellia sinensis* is an evergreen tree or shrub. It has yellow-white flowers and long, serrated leaves. Plants Al-accumulators; myricetin, ellagic acid +; cork pericyclic; (pits vestured); intervessel pitting opposite-scalariform; pericyclic fibres +/0; petiole bundle arcuate; sclereids +, mucilage cells +; stomata usu. anomocytic (anisocytic or cyclocytic); hairs unicellular; leaves spiral, lamina involute or super volute (conduplicate), margins toothed; flowers single, axillary; bracteoles +; C ± free; A usu.

40<, development centrifugal, ± basally connate, anthers versatile, articulated, connective usu. not prolonged, filaments variable in length; anther epidermis ephemeral/partly persistent, middle layer 3-4 cells across; pollen tricolporoidate; nectary?; G [(3-)5(-10)], opposite C, (styles +, separate), stigma wet; ovules 2-few/carpel, (basal), bitegmic, micropyle endostomal, outer integument 4-10 cells across, inner integument 4-11 cells across, hypostase +; antipodals in mature embryo sac 0; fruit a loculicidal capsule, K persistent or not; seeds few, often >4 mm long, flattened; testa massive, exotesta lignified or not, mesotesta lignified (fibrous; with sclereids), endotesta lignified or not; endosperm nuclear/coenocytic, cotyledons longer than radicle, accumbent[9]. Flowering of Camellia sinensis occurs from different varieties of camellias have different flowering periods. It generally blooms early in places with high temperatures and high rainfall.[10][11]. The various tea types are classified according to their processing and related oxidation and fermentation levels that affect the taste and aroma characteristics. Green tea is the least oxidized and unfermented tea. China is the origin center of green tea production. Today, green tea is produced in more than 20 countries/regions in tropical, sub-tropical and temperate regions. Due to its health, sensory, stimulating, relaxing and cultural properties, it is the most widely consumed beverage after water[12][13][14][15].

All shoots on a tree make leafy growth when a new cycle of growth begins in the spring, but terminal buds apparently become dormant as the season advances[16]. Apparently dormant terminal buds shed bud scales, leaving on the stem a considerable number of scars, representing leafless cataphyllary flushes. Apical growth of a tea shoot occurs by a succession of flushed separated short periods of rest[16]. The fertilized ovaries take 10 to 12 months to mature and so reach the dehiscence stage between early October and the end of November the following year. Depending on the dimension, there be dormant periods (high latitudes) and no dormancy periods (low latitudes)[17][18].

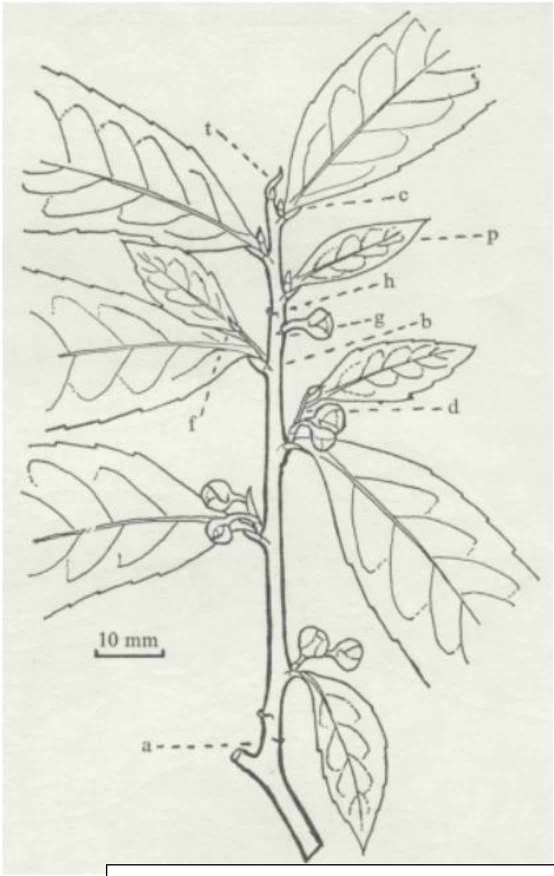


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Fig.1. A two-flush shoot; a – b, first flush; b – c, second flush. Terminal bud, t, in infertile condition; g, h, scars of fallen genome; g, with a flower bud in the axil; d, f, leafy laterals; p, fish leaves

In the dormancy state the bud is very small, only a few mm in length (Fig 1.) and is enclosed usually by two but occasionally by more bud scales (cataphylls). Breaking of dormancy, generally referred to as coming away, is marked by the unfolding of the bud scales which fall off almost immediately, leaving behind their characteristic traces on the stem (Fig 1.) separated by very abbreviated internodes[16]. There is often another leaf-like appendage between the bud scale at the base of the shoot and the first fully serrated normal leaf. Several excessive forms of this appendage can be identified based on their degree of affinity with normal leaves. In the absence of any apparent affinity, it be chlorophyll-deficient with underdeveloped venation (Fig 1.)[16]. With a more pronounced affinity to a normal leaf, this appendage is of rich green colour with a more prominent venation, partially serrated, and persist as long as the normal leaves of the flush to which it belongs, such leafy appendages are commonly known as ‘fish leaves’[16].

The tea plants of commerce are maintained as low bushed by and the new shoots developing from the bush frame are broken back(tipped) to a flat surface, 10 to 25 cm above the pruning level. Shoots developing subsequently from the leaf axil of the tipped shoots and their branches and sub-branches are harvested (plucked) at regular intervals of 7 to 10 days until the end of the growing season. The plucked shoots consisting of 2-3 leaves and the apical bud are used for the manufacture of tea[19].

## 3.1 Varieties suitable for matcha

According to the sensory quality of matcha, the "three originals" such as the original quality, original colour, and original flavour, and the "three clear" characteristics such as fresh fragrance, clear taste and slightly green (grass) air, require tea varieties to have high chlorophyll, amino acid, protein content, and tea polyphenols. Low caffeine content. At the same time, considering the sprouting time and yield of the varieties, the recommended tea varieties suitable for matcha production are Zhongcha 108, Longjing 43, Yabukita, and Okumidori and others. Here we first use these four as examples[20].

**Zhongcha 108**:

A national-level tea tree breed selected by the Tea Research Institute of the Chinese Academy of Agricultural Sciences from Longjing 43 cuttings after radiation mutagenesis. This species is a shrub type, medium-leaf type, very early growing, with long oval leaves, green leaf colour, slightly protruding leaf surface, tapering tip, half-open tree posture, and dense branches. It is characterized by early germination. The buds and leaves are yellow green, with less hairs, strong bud fertility, good tenderness, strong cold resistance, drought resistance and disease resistance. Spring tea generally germinates in early and mid-March with high yield. Suitable for making matcha, with green colour, high aroma and fresh taste[20][21].

**Longjing 43**

A national-level tea tree bred by the Tea Research Institute of the Chinese Academy of Agricultural Sciences from a single plant in the Longjing population. Shrub type, mid-leaf, half-opened, densely branched. The variety is characterized by early germination. The spring buds germinate in mid-March, and the full season of one bud and three leaves is in mid-April. Therefore, all cultivation techniques must also start from the word "Early" to promote the early and rapid growth of spring tea. ; High germination density, strong bud growth ability, short and strong buds and leaves, few hairs, picking resistance, strong cold resistance, weak drought resistance, poor tenderness, suitable for green tea, especially for flat tea such as Matcha and Longjing[20][22].

**Yabukita**

Yabukita is a tea tree bred from China from Japan. In 1955, it was designated as an award-winning variety by Shizuoka Prefecture, and it quickly became popular. Yabukita has strong vitality, is easy to root in any soil, has a uniform root system, germination, and early development. It has strong adaptability and is easy to replant, but its disease resistance is weak, so attention should be paid to prevention and treatment. Germination and maturity are earlier than other varieties in Japan, and the yield is 10% higher than other varieties. Currently, 75% of tea gardens in Japan belong to this type of tea garden. The quality of matcha made by Yabukita is very good, the aroma is moderate, and the bitterness and sweetness are well balanced[20].

**Okumidori**

Introduced varieties from Japan. The leaves are smaller than Yabukita, elliptical, green in colour, buds are well erected, and it is a bud number type with high yield. The cold resistance is equivalent to Yabukita. The product has a strong colour, a unique fragrance, and a soft and sweet taste. The matcha processed with this variety has high amino acid content in fresh leaves, especially high free amino acid content, low phenol-ammonia ratio and catechin content, and excellent quality[20][23].

# 4. Origin of matcha

Matcha originated in China. Chinese matcha has a history of more than a thousand years, but matcha has not been popular since the Ming Dynasty, and instead used tea. Chinese matcha formed a historical period. Japanese Matcha, which is currently quite famous in the world, was brought back to Japan by a Buddhist priest named Eisai Mjóan in the 12$^{th}$ century. Matcha has been preserved in Japan, inherited, and carried forward. And the custom of drinking tea was passed on from the upper class to the samurai society by Senno-Rikyuu (1521-1591), and then gradually passed on to ordinary people. With the opening of the Yokohama trading port in 1859, tea has become a commodity for daily use. And with the invention of machines for processing and mechanical shears for harvesting, the output of tea increased rapidly. Japanese matcha and Japanese tea ceremony have now become Japan's national quintessence, cited as the gift of state guests, known as the best in Japan[24].

# 5. Matcha processing

Matcha processing includes two processes, namely, matcha primary (milled tea) processing and matcha refined processing. There are many processes and high technical requirements. However, the whole process of matcha processing is mechanized, continuous, high in automation, and low in manual usage, which is an effective production method to alleviate the labour difficulty of tea.

The primary processing of matcha tea is also called milled tea processing. The construction of tea milling has a high degree of automation, and generally achieves full-process continuous production. The processing process is Plucking → green storage → leaf cutting → finalization → cooling → initial drying → separation of stems and leaves → re-drying (leaf) → tea grinding, the first stem the stalk part after leaf separation also contains a small number of leaves, and it enters another dryer for re-drying, and then separates the stalks and leaves a second time. The separated leaves are also ground tea after the second re-drying [25].

## 5.1. Preliminary (processing of green tea)

Fresh leaves can be processed at the factory. The fresh leaf storage site should be clean, hygienic, cool, free of peculiar smell, ventilated, and protected from direct sunlight. The thickness of fresh leaves does not exceed 90 cm. During the storage process, care should be taken to maintain the freshness of fresh leaves to prevent them from becoming hot and red. Fresh leaves picked in hot weather at noon become hot or dehydrated after exposure to the sun. An atomizer can be used to cool the fresh leaves to ensure the quality of the fresh leaves[25][26][15].

**Plucking**

Most types of green tea are produced with tender leaves. In order to obtain high-quality tea, it is necessary to pick and process buds including two leaves or buds with three leaves. Green and uniform tea leaves are usually the best green tea quality. Older leaves are generally not used to produce high-quality green tea because these leaves are rough and have astringent taste[15]. After the buds are pulled out, they are usually spread in bamboo trays or on the ground for 1-3 hours to emit a grass-like smell and reduce the moisture to the optimal level to improve the quality of green tea. Green tea can be picked manually or with a picking machine. But many high-quality green teas are picked by hand, mainly by experienced people, who can pick about 40 kilograms of tea per day. Green storage[15][10].

**Leaf cutting**

To make the raw materials uniform, fresh leaves need to be cut. The fresh leaves of the green storage tank enter the leaf cutter at a constant speed through the conveyor belt for cross-cutting and longitudinal cutting, and the length of the fresh leaves at the discharge port is uniform[25].

**Finalization**

Use steam or steam hot air to make the dry tea green. Use saturated steam or high-temperature superheated steam, steam temperature 90-100℃, steam flow rate 100-160 kg/h, green leaf flow rate 90-120 kg/h, drum speed 30-50 rev/min, stirring shaft speed 300-600 R/min, the finishing time is 8-10 seconds[25]. Fresh tea leaves are exposed to heat for about 10 to 15 minutes in a fixation process. Fixation inactivates enzymes in leaf buds to prevent oxidation and fermentation and keep green. The main related enzymes in tea plants include polyphenol oxidase, catalase, peroxidase and ascorbate oxidase[27]. After picking the tea leaves, these enzymes have high activity and must be inactivated by applying high heat during the fixation process[28].

**Cooling**

The final leaves are blown into the air by a fan and are raised and lowered several times in a cooling net of 8 to 10 meters to quickly cool and dehumidify. The cooling time is 5-10 minutes. After cooling until the water in the tea stems and leaves are redistributed, the tea leaves are soft by hand[25].

**Initial drying**

The well-digging brick tea mill is commonly used to form the unique flavour of tea milling "burning incense", but there are also box-type tea mills or far-infrared dryers for initial drying. There are multiple stainless steel conveyor mesh belts with a width of 1.8 to 2.0 meters in the tea mill. The blades travel on the mesh belt by air conveying and changing layers[25]. The physical and chemical changes that occur during the drying process affect the final quality of the tea, which is why the proper drying process must be controlled to maintain quality and minimize energy input. Control the loss of quality and burnt taste by adjusting the drying temperature[29][15].

**Separation of stems and leaves**

Using a stem leaf separator, its structure is a semi-cylindrical metal mesh. The built-in spiral knife peels the leaves from the stems when rotating. The peeled tea leaves enter the high-precision winnowing machine to separate the leaves and tea stems through the conveyor belt. At the same time remove impurities[25][15][10].

**Re-drying (leaf)**

Then use dryer for further drying. Set the dryer temperature to 70 ~ 90℃ for 15 ~ 25 minutes to control the moisture content of the dried leaves below 5%[25][15].

**Tea grinding**

The first processed product of matcha after re-baking is ground tea, which has bright green colour, uniform size, cleanliness, and outstanding seaweed fragrance [25].

## 5.2. Refined

The refined processing process of matcha tea is: cutting tea → sieving → winnowing → crushing → sieving → gold exploration → matcha powder [30].

**Cutting tea**

The tea is cut by a tea cutting machine such as a rolling cutter, a tooth cutter, etc., and the large ones are cut into small pieces, and the long ones are cut short, and then cut and rolled into evenly crushed tea pieces with a size of 0.3 to 0.5 cm[30][26][31].

**Sieving**

After cutting the tea, sieving is performed. During the sieving process, the ground tea that does not meet the specifications is separated, and then cut and rolled, and the sieving is repeated until the specifications are met[30][26].

**Winnowing**

Winnowing is the use of wind to remove yellow flakes, tea stalks and inclusions in the ground tea, separate the ground tea with different weights, and smash it by classification[30][31].

**Crushing**

Crushing is a key process in the refinement of matcha. At present, China's matcha crushing methods mainly include ball milling, stone milling, continuous ball milling, and jet milling[30][26][31].

**Sieving**

The pulverized matcha is passed through a metal sieve to remove the pulverized tea and other surface foreign matter. Generally, an 80-mesh stainless steel metal vibrating sieve is used[30][26].

**Matcha powder**

The matcha powder is bright and green, the particles are soft, fine and uniform, and the fragrance is outstanding [30][26][31].

# 6. Chemical composition and methods

**Catechin content and method**

EGCG (Epigallocatechin gallate) is a catechin, known for its chemical protective properties. It and ECG (Electrocardiography) are the main bioactive component of green tea after caffeine[32][33][34][35][36]. It is a kind of phenolic compound, which is the main colour, flavour, quality, and health ingredient of tea. As a precursor of tannins, catechins are widely distributed in plants and often coexist with corresponding flavonoids.

Estimation of catechin and caffeine content by season for all 31 TV varieties and 4 popular varieties in Northeastern India by Himangshu Deka et al.. Himangshu Deka et al. used the International Standards Organization method (ISO 14502-2:2005) to estimate individual catechins and caffeine by using the relative response factors of catechins to caffeine. Analysis of variance (ANOVA) was performed using SPSS software version 17.00 (SPSS Inc., Chicago, IL). Tukey's multiple comparison test was used to obtain differences between means, and differences were considered significant at $p \leq 0.05$ and $p \leq 0.01$. For each sample, all data are reported as mean ± standard error (SE) for three replicates. Their results show that the content of catechins varies greatly in different seasons: before the monsoon, the EGCG (Epigallocatechin gallate) content is $52.2 \pm 1.07$ mg/g $^{-1}$ - $111 \pm 1.24$ mg/g $^{-1}$, and the EGC (Electrocardiography) content is $17.2 \pm 0.29$ mg/g $^{-1}$ - $52.6 \pm 1.35$ mg/g $^{-1}$; in the monsoon, the EGCG (Epigallocatechin gallate) content is 70.4

± 1.03 mg/g $^{-1}$ - 141 ± 1.35 mg/g $^{-1}$, the EGC (Electrocardiography) content is 52.6 ± 1.35 mg/g $^{-1}$ - 60.2 ± 0.69 mg/g $^{-1}$; in autumn, the EGCG (Epigallocatechin gallate) content is between 58.4 ± 2.47 mg/g $^{-1}$ - 108 ± 2.15 mg/g $^{-1}$, the EGC (Electrocardiography) content is 14.2 ± 0.69 mg/g$^{-1}$ - 49.0 ± 1.07 mg/g$^{-1}$[37]. The contribution of EGCG (Epigallocatechin gallate) to total catechin content was 46 - 49.27% throughout the harvest season. In a study of the seasonal effects of Chinese green tea, EGCG (Epigallocatechin gallate) accounted for 60% of total catechins[37][38]. EGCG (Epigallocatechin gallate) levels in Sri Lankan tea varieties have been reported to be between 41.45 - 120.86 mg/g$^{-1}$[39].
Nor Hafiza Sayuti et al. obtained the results by comparing the HPLC (High-performance liquid chromatography) retention time of the standard (sample: MRM-80015, Tokyo, Japan) with the retention time of MGTE, then the highest EGCG (Epigallocatechin gallate) content in MGTE (Magnesium transporter E) was 95.48 mg/g, and the ECG (Electrocardiography) was 74.48 mg/g[40].

**Caffeine content and method**

Caffeine is an important part of tea beverages, and its caffeine has a unique and pleasant taste. At the same time, it is a powerful antioxidant that can increase the antioxidant potential of beverages [40]. Compared with other green teas, matcha has a relatively high caffeine content, which gives it a unique aroma and flavour[41].

Tereza Koláčková et al analyzed four different types of matcha from different countries (Oxalis Inc., Slušovice, Czech Republic): Shao Xing (country of origin China), Jeju (Korea, bio certified by Korea Control Union Certifications B.V.), Hisui and Asagiri (Japan, bio certified by OCIA, Japan). They determined caffeine using an HPLC system (Thermo Scientific Dionex Ultimate 3000; MA, USA) and a Thermo Scientific Dionex UltiMate 3000 diode array detector type DAD 3000RS. Caffeine content was measured according to Wang et al.[42] with slight modifications. Caffeine was quantified using a Supelco Ascentis C18 column (150 x 4.6 mm; 2.7 µm, Sigma Aldrich, Prague, Czech Republic).

Caffeine was identified based on retention time and standard addition methods. The final data results are between 14.4 ± 0.4 mg/g - 33.9 ± 0.3 mg/g.

In the study by Himangshu Deka et al., the caffeine content was measured using the same method used to measure the catechin content, and the results showed that the caffeine content in green tea was between 20-50 $mg/g^{-1}$[43]. Before monsoon, caffeine content was 27.1 ± 0.32 $mg/g^{-1}$ - 48.7 ± 0.50 $mg/g^{-1}$; during monsoon, caffeine content was 35.3 ± 1.56 $mg/g^{-1}$ - 55.0 ± 1.34 $mg/g^{-1}$; in autumn, The caffeine content was 27.6 ± 1.11 $mg/g^{-1}$ - 40.7 ± 0.42 $mg/g^{-1}$[37]. The caffeine content of tea varieties from Sri Lanka (Punyasiri et al.[39]) and Kenya (Obanda et al.[44]) was between 18.11 and 44.93 $mg/g^{-1}$ and between 27.6 and 49.7 $mg/g^{-1}$, respectively, compared with Himangshu Deka et al. Research is very consistent. Caffeine contributes to the creamy properties of black tea. Therefore, teas that are low in caffeine are considered inferior[43][37].

**Vitamin C content and method**

Vitamin C is a powerful exogenous antioxidant. Due to its properties, it reinforces the immune defence of the body. It is an essential micronutrient in human nutrition which should be supplied every day in adequate amounts [45][46].

Tereza Koláčková et al. dissolved 5 g of matcha in 25 mg of an extraction mixture containing a mixture of methanol, phosphoric acid and water in a ratio of 99.0:0.5:0.5. The samples were shaken in a dark vial for 15 min, then filtered through a nylon filter (13 mm, 0.45 µm). Vitamin C was then determined using Dionex Ultimate 3000 and Dionex Acclaim C8 columns (150 x 2.1 mm; 5 µm, Thermo Scientific, MA, USA). They used samples from four different types of matcha from three different countries (Oxalis Inc., Slušovice, Czech Republic): Shao Xing (country of origin China), Jeju (Korea, bio certified by Korea Control Union Certifications B.V.), Hisui and Asagiri (Japan, bio certified by OCIA, Japan)[40]. Vitamin C was identified using the retention time and method of standard addition [47]. Data obtained by Tereza Koláčková et al. found that the vitamin C concentration in matcha ranged from 1.63 to 3.98 mg/g. Park et al.[48]

recorded the vitamin C content in green tea as 1.35 to 1.53 mg/g. Comparing the findings of Tereza Koláčková et al. and Park et al. shows that matcha has more than twice the vitamin C content of green tea.

**Chlorophyll content and method**

Due to shade growth, matcha has increased chlorophyll content, which is the reason for its unique bright colour[49]. Chlorophyll and its derivatives have strong antioxidant and anti-inflammatory activities[50].

Contents of chlorophyll a and b were established according to Vernon [47]. Tereza Koláčková et al. dissolved a powdered tea sample (0.05 g) in 20 ml of 80% acetone with $CaCO_3$ and left in sunlight for 15 minutes. Extracts were filtered through paper filters and transferred into a 25ml volumetric flask and supplemented with 80% acetone. Spectrophotometric determination at wavelengths 649 and 665 nm was performed. Results were expressed using formulas 11–13:

$$\text{Chl } a \left(\frac{mg}{L}\right) = 11.63\ (A_{665}) - 2.39\ (A_{649}) \tag{11}$$

$$\text{Chl } b \left(\frac{mg}{L}\right) = 20.11\ (A_{649}) - 5.18\ (A_{665}) \tag{12}$$

$$\text{Total chl} \left(\frac{mg}{L}\right) = 6.45\ (A_{665}) + 17.72\ (A_{649}) \tag{13}$$

where $A_{665}$ is absorbance by 665 nm and $A_{649}$ absorbance by 649 nm.

It is estimated that chlorophyll a in matcha is about 4.09 mg/g and chlorophyll b is about 1.42 mg/g[42][51], while the average chlorophyll content in regular green tea is 1.20 mg/g[49]. The results of Tereza Koláčková et al. showed that the contents of chlorophyll a and b were in the range of 1.10-4.32 and 0.46-2.73 mg/g, respectively. Low concentrations of chlorophyll a originate from inappropriate manufacturing processes, as chlorophyll a more likely to emerge from heating[52].

Natthawuddhi Donlao et al. selected the tea tree (C. sinensis) of Boon Rawd Farm, Chiang Rai province located in the north of Thailand for research. They first roasted the samples at different high temperatures (200 and 300 °C) and dried them (80, 120 and 160 °C) to observe the chlorophyll content of green tea at different temperatures. The determination of chlorophyll was slightly modified from the colorimetric method described by Yuanyuan Huang et al.[53] by Natthawuddhi Donlao et al. They then used a UV-VIS spectrophotometer (V-630, Jasco, Tokyo, Japan) based on 663 nm (chlorophyll a) and 645 nm (chlorophyll b). Calculate the content using the following formula:

Content of chlorophyll a (mg/l) =12.7A663 – 2.95A645,

Content of chlorophyll b (mg/l) =22.9A645 – 4.67A663,

Total chlorophyll content (mg/l) =Content of chlorophyll a + Content of chlorophyll b

where A663 and A645 are the absorbance of the sample at 663nm and 645nm, respectively[54].

The results of Natthawuddhi Donlao et al. showed that the total chlorophyll content of dried tea leaves was 2.12-4.44 mg/g[40][54], and the total chlorophyll content of dried tea leaves changed greatly under the baking temperature and drying temperature. The content of chlorophyll in the samples decreased with the increase of drying temperature[54].

# 7. Health effects of matcha on consumers

Consumption of green tea is considered an effective dietary intervention to promote mental clarity and cognitive function, and can improve the mood of middle-aged, overweight, and obese men. These health benefits are mainly attributed to epigallocatechin gallate (EGCG) [55][56]. EGCG (Epigallocatechin gallate) intake enhances cognitive function, improves insulin sensitivity and decreases amyloid-β production in the brain, thus reducing neuroinflammation and preventing neuropathologist related to neurodegenerative diseases, including Alzheimer’s disease[57]. The combination of I-theanine and caffeine present in matcha result in a significant improvement in the performance of alertness or sustained attention tasks, which are mainly related to the regulation of brain neuronal activity and executive control and attention functions[58][59][60]. It is also expected that the caffeine in matcha affect the performance of long-term tasks by other means besides increasing alertness, because in other studies even at high doses, even in the absence of emotional changes, cognitive ability has been observed Improvement[61][62].

Matcha can be used as a suitable substitute to better awaken the organism. The combination of caffeine and L-theanine in matcha is excellent, and due to caffeine, theanine content has an encouraging and soothing effect. The result of the connection is a "keep calm" state, which is an advantage since you should know that excessive coffee consumption can lead to a restless state. L-theanine is a non-essential amino acid that affects certain chemicals in the brain, such as dopamine or serotonin. However, further research results show that matcha can also improve reaction time, concentration, and memory[63]. Therefore, matcha has a good performance on refreshing the mind[63][64].

The cancer preventive activity of green tea and its main component-epigallocatechin gallate (EGCG) has been extensively studied by scientists all over the world. The prevention of primary cancer by green tea is aimed at the general population. It can lead to a delay in the onset of cancer and a decrease in the incidence of cancer. Secondary cancer prevention refers to early cancer diagnosis and treatment for cancer patients in the general population and clinics; the combination of green tea catechins and anti-cancer compounds can prevent third-generation cancers[65][66]. The combination of EGCG (Epigallocatechin gallate) and quercetin synergistically inhibits the stem cell properties of human prostate cancer cells[67], and EGCG (Epigallocatechin gallate) alone also inhibited viability of human pancreatic cancer stem cells in primary and secondary spheroids in a dose-dependent manner. [68] Similar results are increasingly reported by other investigators, indicating that EGCG (Epigallocatechin gallate) and other green tea catechins target cancer stem cells in numerous human cancer tissues. The mechanism behind the anti-cancer effect of EGCG(Epigallocatechin gallate) related to the inhibition of tumour angiogenesis, anti-oxidation and inhibition of transformation, excessive proliferation and the inflammatory process that triggers cancer[69][70].

Features of inflammatory response are the symptoms of many immune cell aggregation at the inflammatory sites, release of proinflammatory cytokines, and reactive oxygen/nitrogen (ROS/RNS). EGCG(Epigallocatechin gallate) inhibits the transfection of NF-B and AP-1 to downregulate the expression of iNOS and COX-2 mainly by scavenging NO, peroxynitrite, and other ROS/RNS and decreases the production of inflammatory factors to show the anti-inflammatory effects [71][72][73]. EGCG (Epigallocatechin gallate) plays a crucial role in the regulation of related gene expression and transcription, which explain its anti-inflammatory properties. By regulating inflammation, EGCG (Epigallocatechin gallate) also helps reduce sensitivity to gallstone formation. Hypertension is controlled by a variety of genes, and inflammation and vascular remodelling are related to the pathogenesis of the disease [74][75]. Supplementing EGCG(Epigallocatechin gallate), the main bioactive component of green tea, can alleviate complications of the inflammatory process caused by cardiopulmonary bypass and major cardiac surgery, including lung injury and dysfunction[76][77].

# 8. Conclusion

Matcha contains high antioxidant components such as polyphenols, vitamin C, etc. The article mentions that because matcha also contains a large amount of EGCG (epigallocatechin gallate), it is used to fight inflammation or delay the onset of cancer, as well as enhance brain function, improve mood, and improve the immune system. But this is not medically certified, only some literature for reference. To confirm whether it has a medical effect, more in-depth research analysis and even clinical trials are needed.

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