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Matcha – an ordinary tea or a superfood with remarkable health benefits? A review of human and animal studies

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Abstract

Introduction: Matcha is a powdered form of green tea characterized by a high content of bioactive compounds, including catechins, caffeine, theanine, vitamins, minerals, and dietary fiber. Owing to its unique cultivation and processing methods, matcha has attracted increasing scientific interest as a functional food with potential health-promoting properties.

Aim: The aim of this review was to summarize current knowledge regarding the chemical composition of matcha tea and to evaluate the evidence concerning its effects on cognitive function, cardiometabolic health, inflammation, cancer prevention, and exercise performance.

Methodology: A narrative review of the available scientific literature was conducted using peer-reviewed articles, reviews, experimental studies, and clinical trials concerning matcha tea and its major bioactive compounds. The collected studies were analyzed to assess the potential health effects and mechanisms of matcha consumption.

Results: The available evidence indicates that matcha may support cognitive function, improve attention, reduce psychological stress, and enhance sleep quality. Furthermore, matcha consumption has been associated with improvements in lipid and glucose metabolism, reductions in obesity-related inflammation and oxidative stress, and favorable effects on cardiometabolic health. The high concentration of catechins, particularly epigallocatechin-3-gallate (EGCG), appears to play a central role in its antioxidant and anti-inflammatory activities. Experimental and epidemiological studies also suggest potential anticarcinogenic properties, while recent findings indicate that matcha supplementation may support adaptation to resistance training by reducing fatigue and enhancing muscle strength.

Conclusions: Matcha tea represents a promising functional food with potential benefits for cognitive, metabolic, and overall health. However, many of the reported effects are based on animal studies or small human trials. Further large-scale, long-term randomized controlled studies are required to confirm these findings and establish evidence-based recommendations for matcha consumption.

Materials and methods: A narrative review of the literature was conducted to summarize the current state of knowledge on the health benefits of matcha green tea. A systematic search of the PubMed database was

performed using the following keywords: „matcha", „matcha green tea", „health benefits", „cognitive function", „cardiometabolic effects", „cardiometabolic health", „epigallocatechin-3-gallate (EGCG)", „inflammation". A narrative review was conducted based on peer-reviewed publications published between 1998 and 2026, with particular emphasis on studies from 2018 to 2026 investigating the health effects of matcha tea and its principal bioactive constituents.

Keywords: Matcha; green tea; epigallocatechin-3-gallate (EGCG); catechins; cognitive function; cardiometabolic health; inflammation; cancer prevention; exercise performance.

Introduction

Tea has been consumed for centuries due to its pleasant taste, cultural significance, social role, and perceived health benefits. Therefore, it should not surprise anyone that it is one of the most commonly consumed beverages worldwide, second only to water [1]. Tea is produced from the leaves of *Camellia sinensis* and can be processed into several varieties, including green, black, oolong, and white tea. The differences among these tea types arise primarily from variations in cultivation, harvesting, and processing methods, which influence their chemical composition and sensory properties. Among these varieties, green tea has attracted considerable scientific interest because of its high content of bioactive compounds and its potential health-promoting effects.

Matcha tea, a powdered form of Japanese green tea (*Camellia sinensis*), has gained increasing popularity worldwide in recent years. Unlike conventional green tea, in which the leaves are infused in water and subsequently discarded, matcha is prepared by suspending finely ground tea powder in water, allowing the consumer to ingest the entire leaf [6]. As a result, matcha provides higher concentrations of many nutrients and phytochemicals than traditional green tea infusions [39]. Matcha powder contains a wide range of biologically active compounds, including catechins, caffeine, L-theanine, chlorophyll, vitamins, minerals, and dietary fiber, all of which may contribute to its potential health benefits [2,3].

The unique composition of matcha is largely attributable to its traditional cultivation method. Unlike most tea plants, which are grown in full sunlight, matcha tea plants are shaded under special canopies for approximately three weeks before harvest [2,3,4]. Shading reduces photosynthetic activity and induces metabolic changes within the plant, leading to increased accumulation of amino acids, particularly L-theanine, as well as higher caffeine and chlorophyll contents. At the same time, the concentrations of certain catechins are modified, resulting in a characteristic balance of compounds responsible for matcha's distinctive umami taste, fresh vegetal aroma, and vibrant green colour [5]. The elevated chlorophyll content not only contributes to its appearance but also reflects the physiological adaptations of the plant to reduced light exposure.

In addition to its unique sensory characteristics, matcha has attracted attention because of its high antioxidant capacity and the presence of epigallocatechin-3-gallate (EGCG), the most abundant and biologically active catechin found in green tea. EGCG has been extensively studied for its antioxidant, anti-inflammatory, neuroprotective, cardioprotective, anti-obesity, and anticarcinogenic properties. Together with other constituents such as caffeine and L-theanine, it is believed to play a central role in the health effects associated with regular matcha consumption.

The growing popularity of matcha as a functional food and dietary supplement has stimulated scientific interest in its potential role in disease prevention and health promotion. Therefore, the aim of this review is to summarize the current knowledge regarding the chemical composition of matcha tea and to discuss the evidence concerning its effects on cognitive function, cardiometabolic health, inflammation, cancer prevention, and exercise performance.

Chemical composition

Matcha tea consists of 60–70% of insoluble ingredients such as fat-soluble vitamins, insoluble dietary fibers, chlorophylls, and proteins, and 30-40% of soluble ingredients like polyphenols, water-soluble vitamins, caffeine, water-soluble dietary fibers, amino acids, saponin, and minerals [6]. Matcha has a high content of dietary fibre, especially the insoluble fraction, which is 94,1% of dietary fibre fractions. Matcha powder is also a good and underestimated source of plant protein, with one tablespoon of dry matcha powder (approximately 12 g) containing 2 g of protein. The total fat content of dry matcha powder was 7.285 g/100 g, with the proportion of unsaturated fatty acids in total fat 83.255%, and 16.745% being saturated fatty acids. The Japanese green tea contains unsaturated fatty acids from several omega families, especially omega-3 (65,412%), omega-6 (12,562%), omega-9 (4,573%), and omega-3 family (0,708%). The most plentiful phenolic compound in matcha tea was caffeine—2213.492 µg/g—while among the phenolic acids, gallic acid had the highest content—252.3755 µg/g [4].

Natural antioxidants abundant in matcha, such as polyphenols- molecules almost as powerful and effective as vitamins like vitamin C, vitamin E, carotene, and tocopherol, are associated with matcha's health benefits [6]. Combined effect of theanine and caffeine [10], theanine [11], caffeine [12,13] and catechins [14] is linked with matcha's positive effect on cognitive function. The most biologically active catechin in matcha is epigallocatechin-3-gallate (EGCG), which is a potent polyphenolic antioxidant that has been extensively studied for its potential health-promoting properties. EGCG exerts its effects through several mechanisms, including scavenging reactive oxygen species (ROS), reducing oxidative stress, modulating inflammatory signaling pathways, and influencing gene expression. Numerous in vitro and animal studies have demonstrated that EGCG may possess anti-inflammatory, anti-obesity, cardioprotective, neuroprotective, and anticarcinogenic properties. As matcha contains particularly high concentrations of catechins due to the consumption of the entire tea leaf, EGCG is considered one of the principal compounds responsible for the beneficial health effects associated with regular matcha consumption [22,25].

Cognitive function, sleep and stress

Bioactive compounds abundant in matcha, such as caffeine, theanine and catechins, have been associated with multiple benefits to cognitive function, memory, focus and sleep. Caffeine is a psychoactive stimulant linked to increased alertness and improved cognitive performance, as demonstrated by numerous studies and systematic reviews. Previous research has also shown that theanine positively affects neurogenesis and cognitive function independently of other compounds present in matcha. Furthermore, caffeine may enhance the effects of theanine on neurophysiological processes, especially those related to attention [6]. EGCG, the strong antioxidant abundant in matcha, plays a key role in maintaining brain function, because the brain structure is particularly vulnerable to oxidative stress due to its higher content of unsaturated fatty acids in contrast to other tissues [35].

Amyloid-β (Aβ) accumulation is a key pathological feature of Alzheimer's disease. The aggregation of Aβ peptides promotes oxidative stress, neuroinflammation, synaptic dysfunction, and neuronal loss, which ultimately leads to progressive cognitive decline and dementia. The catechin ECGC can cross the blood-brain barrier and inhibits both the accumulation and production of Amyloid β, which protects against its toxicity [33, 34]. EGCG is also said to reduce neuroinflammation in the microglial cells in the hypothalamus, which lowers the risk for cognitive decline [19].

Despite the presence of caffeine, which disrupts sleep, matcha demonstrated a sleep-enhancing effect- that is because of theanine. Studies showed that daily theanine intake (200 mg/day) for 4 weeks significantly reduced the total PSQI score and therefore improved sleep quality [28].

The effect of matcha on improving cognitive performance has been a subject of much research. Facial emotion recognition deficits are observed in individuals with subjective cognitive decline (SCD) and mild cognitive impairment MCI [29]. In the recent study, a significant improvement in social cognition was observed following 12-months of matcha consumption. Daily intake of Japanese green tea led to better perception of emotions and recognizing facial expressions [28]. However, it was reported that daily matcha supplementation effectively prevented the cognitive decline of community-dwelling elderly women, based on the Montreal Cognitive Assessment (MoCA) score, with no such effect was observed in elderly men [30]. During a test on mice, matcha intake prevented capillary aging in the limited cortical layer, which vitally contributed to the maintenance of brain function [31]. The recent research showed that ingestion of matcha samples downregulated the expression of the hippocampus brain acid-soluble protein 1, microtubule-associated protein tau, synapsin-2, and sodium- and chloride-dependent GABA transporter, and tended to downregulate the expression of Parkinson's disease 7 and synapsin-1. Moreover, it was proved that these samples upregulated the expression of hippocampus glutathione S-transferase Mu 1, tubulin alpha-1A chain, dynamin-2, calcium/calmodulin-dependent protein kinase type II subunit gamma and tyrosine 3-monooxygenase/tyrosine 5-monooxygenase activation protein epsilon polypeptide. These results indicate the possibility that matcha and decaffeinated matcha could reduce aging and cognitive impairment by regulating the expression of these proteins [32].

Studies suggest that matcha, if consumed regularly, may help reduce psychological stress and anxiety. Continuous matcha intake has been associated with improved performance under stress and enhanced attention, likely due to its combined content of theanine, catechins, and caffeine. Additionally, daily consumption of matcha has been shown to significantly lower both subjective anxiety levels and physiological stress markers compared with a placebo. Compared with caffeine alone, matcha appears to provide greater benefits for stress management. While caffeine can acutely improve attention and reaction time, its effects are mainly short-term, whereas regular matcha intake has been associated with better cognitive performance under stress and potential anti-stress effects. These benefits are thought to result from the combined action of matcha's bioactive compounds, particularly theanine, which may help counterbalance some of the stimulating effects of caffeine [6,14].

Cardiometabolic Effects

Cardiometabolic diseases, including obesity, type 2 diabetes mellitus, and cardiovascular disorders, are among the leading causes of deaths in developed countries worldwide. Obesity itself is a serious problem in developed countries, which untreated properly, inevitably leads to many metabolic syndromes. The number of people with excess body weight is continuously rising, reaching >2 billion, which is ∼30% of the world population [16]. To evaluate the weight-reducing effect, various types of indices are used, such as blood glucose, hemoglobin A1c, lipid profile (e.g., total cholesterol and triglyceride), inflammation-related cytokines (e.g. IL-6 and IL-10), and oxidative stress biomarkers like malondialdehyde (MDA) and SOD [17].

Emerging evidence suggests that matcha tea may have beneficial effects on several cardiometabolic risk factors. The potential weight-loss effects of matcha may be partly attributable to its high levels of phenolic compounds, dietary fiber, and naturally occurring caffeine. A systematic review and dose-response meta-analysis of randomized controlled trials demonstrated that caffeine intake promotes modest reductions in body weight, body mass index, and body fat, suggesting that caffeine may contribute to the anti-obesity effects observed following regular matcha consumption [7] Animal studies have demonstrated that matcha supplementation can attenuate body weight gain, improve blood glucose regulation, and favorably modify lipid profiles by reducing total cholesterol, triglycerides, and low-density lipoprotein (LDL) concentrations while increasing high-density lipoprotein (HDL) levels, ameliorating hepatic steatosis, altering fecal bile acid profile and gut microbiota [15]. The level of low-density lipoprotein-cholesterol (LDL-C) in mice fed with matcha was decreased [18] and the expressions of glucose and lipid metabolism-related genes, such as CCAAT/enhancer-binding proteins-α (C/EBP-α), cluster of differentiation 36 (CD36), and acetyl-CoA acetyltransferase 2 (ACAT2) were decreased in the livers of obese mice [15]. Moreover, dietary supplementation with 1% matcha attenuated the HFD-induced increase in hepatic alanine aminotransferase (ALT) and aspartate aminotransferase (AST) activities in mice. It also improved obesity-associated fatty liver damage and inflammation, potentially through the inhibition of the TLR4/MyD88 signaling pathway [19]. It was also proved that catechins from green tea significantly lowered fasting blood glucose concentrations (−1.48mg/dL; 95% CI: −2.57, −0.40mg/dL) but did not affect fasting blood insulin, HbA1c, or HOMA-IR levels [8]. Therefore, the use of matcha in the treatment of obesity sounds promising.

Furthermore, matcha has been shown to reduce visceral and hepatic fat accumulation and improve liver function markers in mice fed a high-fat diet. These effects may be partly attributed to the high concentration of catechins, particularly epigallocatechin-3-gallate (EGCG), which influences lipid metabolism by regulating genes involved in fatty acid synthesis and storage [15]. In addition, the antioxidant and anti-inflammatory properties of matcha may help counteract obesity-associated oxidative stress and chronic low-grade inflammation, both of which contribute to the development of cardiometabolic disorders. Other bioactive compounds present in matcha, including caffeine and theanine, may further support metabolic health by improving insulin sensitivity, reducing inflammation, and contributing to blood pressure regulation. Although the available animal studies consistently report beneficial effects, further large-scale human clinical trials are needed to confirm the cardiometabolic benefits of regular matcha consumption.

Anti-inflammatory effect

Inflammation is a foundation of many diseases. Inflammatory reaction leads to the excessive production of inflammatory cytokines (e.g., TNF-α, IL-1β, and IL-6), chemokines (e.g., chemokine C-C motif ligand 2 and chemokine CXC motif ligand 8) and PGE2 [21]. This cascade generates reactive oxygen species (ROS), which can damage cell structures and cause long-term impairment of the body's overall functioning. The principal effect of anti-inflammatory and antioxidant agents is the attenuation of inflammatory signalling through ROS scavenging [22]. The main molecule responsible for the anti-inflammatory effect of matcha tea is epigallocatechin-3-gallate (EGCG). Studies on macrophage cell line and infected rabbits showed that EGCG reduces NO, COX-2, IL-6, IL-1β, and TNF-α [20,23].

The anti-inflammatory activity of EGCG is mediated through the modulation of several intracellular signaling pathways involved in the inflammatory response. In particular, EGCG has been shown to inhibit the activation of nuclear factor kappa B (NF-κB), a key transcription factor regulating the expression of numerous pro-inflammatory mediators [23,36]. By suppressing NF-κB signaling, EGCG may reduce the production of cytokines and enzymes that contribute to chronic inflammation and tissue damage. Furthermore, EGCG exhibits strong antioxidant properties, limiting the generation of reactive oxygen species and protecting cells from oxidative injury. These effects are particularly relevant because chronic low-grade inflammation is recognized as an important contributor to the development of cardiovascular diseases, metabolic disorders, neurodegenerative diseases, and certain cancers. Therefore, the anti-inflammatory properties of matcha tea may represent one of the key mechanisms underlying its potential health-promoting effects.

Anticarcinogenic effects

The anticancer activity of EGCG present in matcha tea may be linked to several mechanisms, including the inhibition of tumour angiogenesis, its antioxidant activity, and the suppression of inflammatory processes that contribute to cellular transformation, hyperproliferation, and the initiation of carcinogenesis. In addition, EGCG has been shown to regulate multiple signalling pathways involved in cell proliferation, apoptosis, and metastasis. Experimental studies suggest that EGCG can induce programmed cell death in malignant cells, inhibit tumour cell growth, and interfere with pathways responsible for cancer progression. Its antioxidant properties may also protect cellular DNA from oxidative damage by reducing the accumulation of mutations that can initiate carcinogenesis.

The data suggest a positive association between higher green tea consumption and a later age at cancer onset. This trend is particularly evident among females, where individuals consuming ≥10 cups of green tea per day exhibited a substantially higher average age at cancer onset (74.3 ± 2.2 years) compared with those consuming fewer than 10 cups daily. A similar, although less pronounced, pattern was observed in males. These findings indicate that regular, high consumption of green tea may be associated with a delayed onset of cancer, especially in women. The data also suggest that higher green tea consumption (≥5 cups per day) is associated with a lower recurrence rate of breast cancer and a longer disease-free period among patients with Stage I and II disease. Specifically, recurrence rates were lower (16.7% vs. 24.3%) and disease-free survival was longer (3.6 vs. 2.8 years) in those with higher green tea intake. However, no beneficial association was observed among Stage III patients, where recurrence rates were higher and disease-free survival remained unchanged regardless of green tea consumption. These findings indicate that the potential protective effects of green tea may be more pronounced in the early stages of breast cancer.

Another important mechanism may involve the inhibition of tumour invasion and metastasis. Green tea and EGCG increased the average value of Young's modulus of cancer cells (cell stiffness) and inhibited cell motility [23,24]. Increased cell stiffness may reduce the ability of cancer cells to migrate and invade surrounding tissues, thereby limiting metastatic potential. Furthermore, EGCG has been reported to suppress angiogenesis, the process through which tumours develop new blood vessels to support their growth and dissemination. By limiting the tumour blood supply, EGCG may contribute to the inhibition of tumour progression.

Research findings regarding supplementation with EGCG also include inhibition of the growth and proliferation of gallbladder and bile duct cancer cells, a decreased risk of biliary tract cancer, and the prevention of recurrent adenomas, which may eventually progress to colorectal cancer [22,26]. Although these findings are promising, much of the available evidence originates from in vitro experiments, animal studies, or observational studies. Therefore, additional large-scale randomized clinical trials are needed to establish the efficacy of matcha and its catechins in cancer prevention and treatment in humans.

Effect on muscle strength and resistance-training

Matcha green tea may help in muscle adaptation to training through modulation of stress and fatigue responses, antioxidant activity, and alterations in gut microbiota composition. Recent studies have shown that daily matcha intake increased maximum leg strength following a resistance-training program compared with a placebo group. Participants consuming matcha also reported lower subjective feelings of fatigue, suggesting improved recovery and adaptation to exercise. Gut microbiota analysis revealed significant changes following matcha supplementation. In particular, the abundance of *Ruminococcus* was significantly higher at week 4 in the matcha group than in the placebo group, and this increase was positively correlated with improvements in maximum leg press strength [27].

The beneficial effects of matcha on exercise performance may be partly explained by its rich content of catechins, especially EGCG, as well as caffeine and theanine. Intense physical activity increases oxygen consumption and promotes the generation of reactive oxygen species (ROS), which can contribute to oxidative stress, muscle fatigue, and delayed recovery [37]. The antioxidant properties of matcha may help counteract these effects by scavenging free radicals and reducing exercise-induced oxidative damage [38]. In addition, the anti-inflammatory effects of catechins may facilitate tissue recovery and adaptation following strenuous exercise.

Caffeine naturally present in matcha may also contribute to improved exercise performance by increasing alertness, reducing perceived exertion, and enhancing neuromuscular function [9]. At the same time, theanine may help attenuate psychological stress associated with intensive training, potentially promoting better recovery and overall well-being [3]. The combination of these bioactive compounds may therefore provide benefits different than those observed with caffeine alone.

Overall, matcha green tea consumption during resistance training may facilitate muscle adaptation by reducing exercise-induced stress and fatigue, which leads to faster recovery and better training outcomes. Additionally, positive correlations between muscle adaptation and alterations in the gut microbiota suggest a potential link between microbiome composition and adaptive responses to training. Although current findings are promising, further studies are needed to determine the optimal dose and duration of matcha supplementation and to confirm its effectiveness in different athletic and non-athletic populations.

Conclusions

In conclusion, matcha green tea is a unique functional food rich in bioactive compounds, including catechins, caffeine, theanine, vitamins, minerals, and dietary fiber, which may contribute to a wide range of health-promoting effects. Current evidence suggests that regular matcha consumption may support cognitive function, improve attention, reduce psychological stress, and enhance sleep quality, largely through the synergistic actions of caffeine and theanine [6,10,14,28]. Recent research also indicates potential neuroprotective effects and a role in maintaining cognitive performance during aging [28,30–32]. In addition, matcha may contribute to weight management and metabolic health by improving lipid and glucose metabolism and reducing obesity-related complications [15,17,19]. Its high concentration of antioxidant compounds, particularly EGCG, appears to underlie its anti-inflammatory properties and may help attenuate oxidative stress and inflammatory signaling pathways [20,22,23]. Furthermore, epidemiological and experimental studies suggest that green tea polyphenols may possess anticarcinogenic properties and could help to delay cancer onset and reduce recurrence in selected populations [24–26].

Emerging evidence also suggests that matcha may exert beneficial effects on cardiometabolic health by improving blood lipid profiles, reducing hepatic fat accumulation, and modulating pathways involved in glucose and lipid metabolism [15,18,19]. These effects are thought to be mediated by catechins, particularly EGCG, as well as dietary fiber, caffeine, and theanine, which may act synergistically to attenuate obesity-associated inflammation and oxidative stress [15,19]. However, the majority of these findings originate from animal studies, and further human clinical trials are required to establish the effectiveness of matcha in the prevention and management of cardiometabolic diseases.

Recent findings also indicate that matcha supplementation may enhance adaptation to resistance training by reducing fatigue and supporting muscle strength development [27]. Nevertheless, many of the reported benefits are based on animal studies or relatively small human trials, limiting the generalizability of the findings [6]. Therefore, larger, long-term randomized controlled studies are needed to confirm the health effects of matcha on the muscular system and establish optimal intake recommendations. Overall, the available evidence supports matcha as a promising dietary component with potential benefits for cognitive, cardiovascular, metabolic, and overall health.

Disclosure*

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