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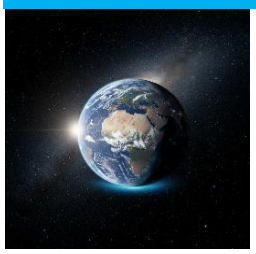

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The Effects of Matcha on the Functioning of Selected Body Systems: A Literature Review

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Abstract

Matcha, a powdered green tea originating from Japan, is a rich source of polyphenols, catechins, L-theanine, caffeine, vitamins, and minerals. This review summarizes current evidence regarding the potential effects of matcha consumption on selected physiological systems and overall human health. Available data suggest that regular intake of matcha may exert beneficial effects on the cardiovascular system and demonstrate antioxidant, anticancer, and neuroprotective properties, while also supporting stress reduction and cognitive function. However, the magnitude of these effects appears to depend on factors such as the quality of raw materials, cultivation conditions, and preparation methods. Although existing findings are promising, a substantial proportion of the available evidence originates from in vitro studies, animal models, and limited clinical trials, which restricts the strength of current conclusions. Therefore, matcha should be considered a complementary component of a healthy diet rather than a substitute for established preventive or therapeutic strategies. Further well-designed clinical studies involving larger populations and longer follow-up periods are required to more precisely determine its potential impact on human health.

Keywords
matcha; green tea; polyphenols; catechins; L-theanine; EGCG; health effects

Introduction

Tea is one of the most widely consumed beverages worldwide and has been an important component of human diets for centuries [1]. In recent years, increasing scientific attention has been directed toward matcha, a powdered form of green tea distinguished by its unique cultivation method and nutritional composition.

Matcha originates from Japan and is traditionally associated with Japanese tea ceremonies [2]. Like other types of tea, it is derived from the leaves of *Camellia sinensis*, but it differs from black and oolong teas in the degree of processing. Green tea is produced from non-fermented leaves, which allows the preservation of higher concentrations of polyphenols responsible for many of its biological activities [3].

The cultivation and processing of matcha are distinctive. Tea plants are shaded several weeks before harvest, which reduces sunlight exposure and promotes the accumulation of amino acids, chlorophyll, and L-theanine [4]. After harvesting, the leaves are briefly steamed, dried, and ground using traditional stone mills, producing a fine powder that is later mixed with water to prepare the beverage [5].

Because matcha is consumed as the entire powdered leaf rather than as a traditional infusion, it provides higher concentrations of bioactive compounds such as polyphenols, catechins, and L-theanine. These compounds have been associated with antioxidant activity and potential physiological benefits [6,7].

The aim of this review is to summarize current evidence regarding the potential effects of matcha consumption on selected body systems and to discuss its possible implications for human health.

Chemical Composition of Japanese Matcha Tea

Matcha green tea contains numerous bioactive compounds, including catechins, amino acids, vitamins, caffeine, chlorophyll, and minerals (Table 1). These compounds are responsible for many of the biological effects attributed to matcha consumption.

Matcha green tea is a rich source of L-theanine and catechins, which exhibit strong antioxidant properties and may contribute to the health benefits associated with its consumption [8]. The cultivation of matcha is distinctive, with one of the most important stages being the shading of *Camellia sinensis* plants approximately 3-4 weeks before harvest. Limiting sunlight exposure promotes the accumulation of amino acids, particularly theanine, which contributes to the relaxing properties and the characteristic umami flavor of the beverage [9].

In addition to theanine, matcha contains polyphenols, particularly epigallocatechin gallate (EGCG), a catechin derivative and a potent antioxidant. Studies have shown that the EGCG content in matcha (expressed in mg/g of dry leaf) may be up to 137 times higher than in some conventional green tea preparations [10]. EGCG has also been shown to protect endothelial progenitor cells from oxidative stress by reducing intracellular reactive oxygen species [11].

Besides L-theanine and catechins, matcha also contains vitamins A, B, C, and E, amino acids, chlorophyll, caffeine, dietary fiber, and numerous minerals such as potassium, selenium, chromium, zinc, and magnesium [8,12].

Table 1. Major bioactive compounds present in matcha green tea.

Compound group	Examples	Main biological properties	References
Catechins (polyphenols)	EGCG, epicatechin	Strong antioxidant activity; protection against oxidative stress	[10,11]
Amino acids	L-theanine	Relaxation effects; modulation of neurotransmitters; contribution to umami taste	[8,9]
Vitamins	A, B, C, E	Antioxidant and metabolic support	[8,12]
Alkaloids	Caffeine	Central nervous system stimulation; increased alertness	[8]
Minerals	Potassium, selenium, chromium, zinc, magnesium	Support of enzymatic and metabolic processes	[8,12]
Other components	Chlorophyll, dietary fiber	Antioxidant activity; digestive support	[8]

Neurocognitive and Psychological Effects

A randomized controlled trial conducted by K. Uchida and colleagues (2024) demonstrated that regular consumption of matcha in older adults with mild cognitive impairment may positively influence emotional perception and sleep quality. In the study, 99 participants received either 2 g of matcha or a placebo daily for 12 months. Participants in the matcha group showed a significant improvement in the recognition of emotions based on facial expressions (social acuity score, mean difference -1.39; 95% CI: -2.78 to -0.002; $p = 0.028$) and a trend toward improved sleep quality (Pittsburgh Sleep Quality Index, difference 0.86; 95% CI: -0.002 to 1.71; $p = 0.088$). These findings suggest that daily matcha consumption may represent a simple and potentially effective strategy for supporting cognitive function and overall well-being in individuals with mild neurocognitive impairment [13].

The biological mechanisms underlying these effects are thought to be associated with the activity of polyphenols present in matcha, particularly epigallocatechin gallate (EGCG) and epicatechin (EC). These compounds neutralize reactive oxygen species (ROS) and reactive nitrogen species (RNS), inhibit the activity of pro-inflammatory enzymes such as nitric oxide synthase, cyclooxygenases, and lipoxygenases, and modulate transcription factors including NF-κB and AP-1. Additionally, they stimulate the activity of antioxidant enzymes such as glutathione transferases and superoxide dismutases. EGCG may also influence the metabolism of neurotoxic proteins such as β-amyloid (Aβ), α-synuclein, and huntingtin, enhance the clearance of phosphorylated tau protein, and reduce the neurotoxic effects associated with Aβ accumulation. Consequently, regular matcha consumption may contribute to improved mood and sleep quality, support emotional perception, and help protect cognitive function through antioxidant mechanisms and modulation of protein pathologies associated with Alzheimer's disease [14].

Research also suggests a potential antidepressant effect of matcha. In an animal study described by Y. Kurauchi and colleagues (2023), administration of matcha to mice exposed to social isolation stress reduced immobility time in the tail suspension test. This effect appeared to be dependent on activation of the dopaminergic system. These findings indicate that matcha may influence mood through modulation of dopaminergic signaling, providing a rationale for further research into its potential role in the prevention and supportive treatment of mood disorders [15].

Anticancer and Anti-Inflammatory Effects

Chronic inflammation is associated with many long-term diseases and is often accompanied by excessive production of reactive oxygen species (ROS), which can damage cells and intensify inflammatory responses. Compounds with anti-inflammatory and antioxidant properties, such as epigallocatechin gallate (EGCG) present in matcha, may help limit these processes by neutralizing free radicals and inhibiting the activation of signaling pathways involved in the development of inflammation. This contributes to maintaining oxidative balance in the body and may protect tissues from the effects of persistent inflammatory processes [16,17].

EGCG and other polyphenols have also been shown to exert antiproliferative effects, which may influence mechanisms involved in carcinogenesis, including breast and colorectal cancer [18,19]. The mechanisms underlying these effects include inhibition of cancer cell proliferation,

induction of apoptosis, and modulation of cellular metabolism as well as transcription factor activity [20]. Polyphenols may induce apoptosis in malignant cells, and in experimental models this effect appears to occur preferentially in cancer cells compared with normal tissues. This activity is associated with inhibition of signaling pathways such as NF-κB and STAT3, modulation of MAPK and PI3K/Akt kinases, and the induction of oxidative stress leading to caspase activation.

Additionally, EGCG has been shown to limit angiogenesis, migration, and invasion of cancer cells, thereby reducing the metastatic potential of tumors [21]. Studies also indicate that polyphenols may inhibit the development of cancer stem cells (CSCs), which play a crucial role in tumor recurrence, metastasis formation, and resistance to therapy [18,19].

Body Weight Reduction

A study conducted by M.E.T. Willems and colleagues in 2018 investigated the effects of matcha consumption on fat oxidation during brisk walking in women. The study included 13 female participants (mean age 27 ± 8 years, body weight 65 ± 7 kg, height 166 ± 6 cm). A standardized exercise protocol with a fixed intensity of 5-6 METs was applied, and measurements were performed during the follicular phase of the menstrual cycle. Participants consumed matcha on the day preceding the trial as well as immediately before the walking session.

The results showed that matcha intake did not significantly affect basic physiological parameters or the perceived intensity of exercise. However, a decrease in the respiratory exchange ratio (RER; control 0.84 ± 0.04 vs. matcha 0.82 ± 0.04; $p < 0.01$) was observed, along with an increase in fat oxidation during the 30-minute walking session (control 0.31 ± 0.10 g/min; matcha 0.35 ± 0.11 g/min; $p < 0.01$). These findings suggest that matcha consumption may increase fat oxidation during moderate-intensity physical activity.

However, the observed effect was moderate; therefore, in the context of body weight reduction, matcha should be considered a supportive element rather than a primary factor influencing weight loss [22].

Cardiovascular Diseases

Regular consumption of green tea, including matcha, may have beneficial effects on the cardiovascular system. Studies suggest that green tea supplementation may reduce total cholesterol and low-density lipoprotein (LDL) levels while increasing high-density lipoprotein

(HDL) cholesterol. Additionally, reductions in fasting blood glucose levels and diastolic blood pressure have been reported [23].

An analysis of data from a large epidemiological study involving more than 40,500 Japanese residents suggests that higher green tea consumption is associated with a lower risk of mortality from cardiovascular diseases, particularly among women [24]. These findings suggest a potential protective effect associated with regular green tea consumption.

Based on these observations, incorporating matcha into the daily diet may support cardiovascular health. However, it should not replace established preventive strategies such as maintaining a balanced diet, engaging in regular physical activity, and addressing modifiable cardiovascular risk factors.

Liver Function and Lipid Metabolism

Studies suggest that matcha consumption may have beneficial effects on lipid metabolism and liver function. In animal models, supplementation with matcha at concentrations of 0.2-1% led to a reduction in hepatic fat accumulation, lower triglyceride and cholesterol levels, and improvement in metabolic parameters such as glucose concentration, insulin levels, and the HOMA-IR index. Additionally, favorable changes in the composition of gut microbiota were observed, which may indirectly support proper liver function [25].

Similar findings have been reported in mice fed a high-fat diet. Matcha supplementation was shown to reduce lipid accumulation in the liver, decrease inflammatory responses, and improve liver function parameters. Gene expression analyses confirmed reduced activity of proteins associated with lipid storage as well as increased activity of detoxification enzymes [26].

Studies conducted in animal models suggest that catechins present in matcha may support lipid metabolism, reduce cholesterol and glucose levels, and improve liver function parameters. However, data from human studies remain limited and further well-designed clinical research is needed to confirm these findings [27].

Potential Adverse Effects

Although the consumption of matcha and other green tea-based products is associated with numerous health benefits, it is not entirely free of potential risks. According to the European Food Safety Authority (EFSA), traditional green tea infusions are generally considered safe;

however, very high intake of catechins-particularly doses of ≥800 mg of epigallocatechin gallate (EGCG) per day has been associated with a significant increase in liver enzyme activity in adults. This may indicate a potential risk of liver injury [28].

A case of acute hepatitis has also been reported in a 63-year-old woman who was taking a concentrated green tea extract. This case highlights that natural plant-based products may also cause adverse effects, particularly when consumed in the form of highly concentrated preparations [29].

In light of these findings, matcha consumption may be considered a component of a healthy lifestyle. However, caution is advised in situations associated with increased risk, such as very high intake, the use of supplements containing large doses of green tea extract, or in individuals with liver disease or other underlying health conditions [28,29].

Conclusions

Matcha is a rich source of various bioactive compounds, including catechins, L-theanine, and caffeine, which exhibit antioxidant and anti-inflammatory properties. Available research suggests that regular matcha consumption may have beneficial effects on the nervous system, lipid metabolism, liver health, cardiovascular function, and processes related to body weight regulation. However, most of the current evidence comes from in vitro studies, animal models, and a limited number of clinical trials, which makes it difficult to draw definitive conclusions regarding its role in disease prevention or treatment in humans.

To better understand the potential health effects of matcha, further well-designed clinical studies involving larger populations and longer follow-up periods are required. Moderate inclusion of matcha in the daily diet appears to be safe and may serve as a complementary component of a healthy lifestyle.

Disclosure

Author Contributions

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Conflicts of Interest

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List of Abbreviations

Aβ - β-amyloid
ABTS - 2,2′-azinobis(3-ethylbenzothiazoline-6-sulfonic acid)
ALT - alanine aminotransferase
AP-1 - activator protein 1
AST - aspartate aminotransferase
CI - confidence interval
COX - cyclooxygenase
CSCs - cancer stem cells
DPPH - 2,2-diphenyl-1-picrylhydrazyl
EC - epicatechin
EGCG - epigallocatechin gallate
GCG - gallocatechin gallate

HDL - high-density lipoprotein
HOMA-IR - homeostasis model assessment of insulin resistance
LDL - low-density lipoprotein
MAPK - mitogen-activated protein kinases
MASLD - metabolic dysfunction-associated steatotic liver disease
MET - metabolic equivalent of task
NF-κB - nuclear factor kappa B
NOX - NADPH oxidase
PI3K/Akt - phosphatidylinositol 3-kinase/protein kinase B signaling pathway
PSQI - Pittsburgh Sleep Quality Index
RER - respiratory exchange ratio
RNS - reactive nitrogen species
ROS - reactive oxygen species
SOD - superoxide dismutase
STAT3 - signal transducer and activator of transcription 3

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