QUALITY IN SPORT
eISSN 2450-3118 · Open Access · Peer-reviewed
apcz.umk.pl/QS Nicolaus Copernicus University in Toruń

DUCZMAL-ZOWCZAK, Dominika, ZOWCZAK, Tomasz, DUCZMAL, Jakub Tomasz, KALITA, Maciej and KRAJEWSKA, Natalia. Matcha as a source of bioactive compounds - current evidence on biological properties and potential clinical relevance. Quality in Sport. 2026;73:75323. https://doi.org/10.12775/QS.2026.73.75323

ARTICLE TIMELINE
Received: 14.08.2026. Accepted: 12.09.2026. Published: 14.09.2026.

The journal has been awarded 20 points in the parametric evaluation by the Polish Ministry of Higher Education and Science (Annex to the announcement of 05.01.2024, No. 32553). Unique Journal Identifier: 201398. Scientific disciplines assigned: Economics and Finance (Field of Social Sciences); Management and Quality Sciences (Field of Social Sciences).
Punkty Ministerialne z 2019 – aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398. Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

Matcha as a source of bioactive compounds - current evidence on biological properties and potential clinical relevance.

Dominika Joanna Duczmal-Zowczak, ORCID https://orcid.org/0009-0007-8902-7283

e-mail: domidu01@gmail.com

COPERNICUS Medical Entity Ltd., Gdańsk, Poland

Tomasz Zowczak, ORCID https://orcid.org/0009-0004-1027-239X

e-mail: tomasz-zowczak@wp.pl

10th Military Clinical Hospital with Outpatient Clinic, Independent Public Health Care Institution, *Department of Maxillofacial, Oncological and Reconstructive Surgery*

Bydgoszcz, Poland

Jakub Tomasz Duczmal, ORCID https://orcid.org/0009-0005-3744-2595

e-mail: jakub.duczmal@cm.umk.pl

Collegium Medicum in Bydgoszcz, Department of Anatomy, Bydgoszcz, Poland

Maciej Kalita, ORCID https://orcid.org/0009-0002-6636-0503

e-mail: kalita.maciej00@gmail.com

University Clinical Centre of the Medical University of Warsaw, Independent Public Central Clinical Hospital, Warsaw, Poland

Natalia Krajewska, ORCID https://orcid.org/0009-0006-8360-1689

e-mail: nataliakrjwsk@gmail.com

University Clinical Centre of the Medical University of Warsaw, Independent Public Central Clinical Hospital, Warsaw, Poland

Corresponding author: Maciej Kalita, kalita.maciej00@gmail.com

Abstract

Background: Matcha is a powdered form of *Camellia sinensis* produced using shaded cultivation and consumed as whole powdered tea leaves, resulting in exposure to bioactive compounds including catechins, caffeine, L-theanine and chlorophylls.

Aim: To review current evidence on the chemical composition and potential health-promoting effects of matcha, emphasizing metabolic health, cognitive function, psychological stress, physical performance, gut microbiota and periodontal health, distinguishing human studies from experimental models.

Materials and methods: PubMed-indexed peer-reviewed studies, randomized controlled trials, experimental investigations, animal studies and reviews addressing matcha were analyzed. Twenty-seven sources were included.

Results: Matcha contains high amounts of epigallocatechin gallate, L-theanine, caffeine and chlorophylls, varying by processing. Preclinical studies indicate antioxidant, anti-inflammatory and metabolic effects, including modulation of lipid metabolism, gut microbiota and the gut-liver axis. Human studies suggest matcha may increase fat oxidation during walking, moderate resistance training fatigue, and maintain attention after stress. Cognitive findings are mixed, without clear long-term global improvements. Matcha shows antimicrobial activity against pathogens like *Porphyromonas gingivalis*, with preliminary periodontal benefits.

Conclusions: Matcha is a bioactive-rich dietary source with strong experimental activity. Clinical evidence for metabolic, cognitive and periodontal benefits remains limited by heterogeneous study designs. Further long-term trials are required.

Keywords: matcha, *Camellia sinensis*, catechins, L-theanine, gut microbiota, metabolic health, cognitive function, psychological stress, periodontal health

1. Introduction

Functional foods have become the subject of intensive research because, in addition to providing essential nutrients, they may supply biologically active compounds capable of influencing physiological functions.[1,2,4,5] Against this background, plant-derived products rich in polyphenols have attracted particular attention, with green tea (*Camellia sinensis*) and its powdered form, matcha, occupying a prominent position.[1,3,4]

Matcha differs from conventional green tea in terms of cultivation and processing, as well as the manner in which it is consumed. Plants intended for matcha production are shaded before harvesting, which affects leaf metabolism and the resulting chemical profile.[1,3,4] The leaves are subsequently steamed, dried, ground, and the resulting powder is consumed together with the entire plant matrix.[1,3,4]

Catechins, particularly epigallocatechin gallate (EGCG), as well as L-theanine and caffeine, are among the most important constituents of matcha. It also contains other polyphenols, flavonoids, chlorophylls, carotenoids, vitamins, and minerals.[1,2,4,5,20] The complexity of its chemical composition means that the biological effects of matcha should not be attributed solely to a single compound but rather considered as a possible result of interactions among multiple constituents.[3-5]

Previous studies have indicated potential antioxidant and anti-inflammatory activity of matcha, as well as possible effects on lipid and glucose metabolism, body weight, the gut microbiota, cognitive function, stress responses, and processes occurring within the oral cavity.[1-7,11,13-16] However, some of these observations originate from in vitro studies or animal models, which limits their direct extrapolation to human health.[2,4]

More recently, randomized clinical trials have examined the effects of regular matcha consumption on cognitive function in older adults, attention during psychological stress, sleep quality, and periodontal health parameters.[8-10,14,17,18] Nevertheless, clinical findings remain heterogeneous, and the observed effects often concern selected parameters rather than an overall improvement in health status.[8-10,14]

This paper critically evaluates the available evidence concerning the chemical composition and potential biological effects of matcha, taking into account differences between experimental and clinical evidence. Particular attention is given to the potential effects of matcha on metabolism, the gut microbiota and gut-liver axis, cognitive function and stress, as well as the possible use of its antimicrobial properties in dentistry.

2. Objective of the article

The objective of this article is to critically review the current scientific evidence concerning the chemical composition, biological activity and potential health-promoting properties of matcha green tea. Particular attention was given to the major bioactive constituents of matcha, including catechins, caffeine, L-theanine and other polyphenolic compounds, as well as to their proposed antioxidant, anti-inflammatory and metabolic effects.[1,5,9,10,25] The article also aimed to assess the available evidence regarding the potential influence of matcha consumption on metabolic health, obesity, hepatic steatosis, gut microbiota, cognitive function, psychological stress, physical performance and periodontal health.[2-4,6-8,11-23,27] An additional objective was to distinguish findings obtained from human clinical studies from those derived from animal and in vitro experiments, thereby assessing the current strength of evidence and identifying areas in which further clinical research is required.[2,5,9,11]

3. Materials and methods

The methodology of this review involved an analysis of peer-reviewed scientific literature concerning matcha green tea and its potential biological and health-related effects. The literature comprised review articles, critical reviews, randomized controlled trials, clinical and clinico-microbiological studies, animal experiments, in vitro investigations and a study protocol addressing the effects of matcha consumption on the gut microbiota.[1-27] The selected literature was identified primarily through PubMed and through the full-text scientific databases and journal platforms provided with the individual publications. The search strategy focused on combinations of terms including: “matcha”, “matcha green tea”, “*Camellia sinensis*”, “catechins”, “EGCG”, “L-theanine”, “antioxidant activity”, “metabolism”, “obesity”, “NAFLD”, “MASLD”, “gut microbiota”, “cognitive function”, “stress”, “sleep”, “physical performance”, “periodontal health” and “antimicrobial activity”. A total of 27 publications were selected for the present review. The included studies were subsequently analysed according to the type of evidence provided, with particular emphasis on the distinction between experimental and animal findings and results obtained in human populations. This approach was adopted to provide a balanced assessment of the potential health effects of matcha while avoiding direct extrapolation of preclinical findings to clinical practice.[1,2,5,9-11]

4. Characteristics, production, and chemical composition of matcha

4.1. Characteristics of matcha

Matcha is a powdered form of green tea obtained from the leaves of *Camellia sinensis*. Its characteristic feature is consumption of the entire powdered leaf rather than only the aqueous extract obtained during brewing.[1,3,4] Consequently, constituents retained in the insoluble fraction of the leaf also enter the consumer's gastrointestinal tract.[3]

The specific cultivation technology includes shading the plants before harvesting. Reduced light exposure affects leaf metabolism and promotes increased chlorophyll and L-theanine content, while also modifying the profile of catechins and other bioactive constituents.[1,4,5] After harvesting, the leaves are steamed, which limits the activity of enzymes responsible for polyphenol oxidation, and are subsequently dried and ground.[1,3,4]

The technological process has an important influence on the final chemical composition of the product. The content of individual constituents is affected by, among other factors, plant variety, cultivation conditions, duration of shading, harvesting time, processing methods, and storage conditions.[1,4,20,21]

4.2. Major bioactive compounds

Catechins constitute the most important group of bioactive compounds present in matcha. The principal representatives include epicatechin (EC), epicatechin gallate (ECG), epigallocatechin (EGC), and epigallocatechin gallate (EGCG).[1,20] EGCG is one of the most important and extensively studied catechins in green tea and has been associated with numerous biological effects observed in experimental studies.[1,2,4]

Another important constituent is L-theanine. This amino acid is characteristic of tea, and its concentration is modified by shading plants before harvesting.[1,15] L-theanine is of particular interest in the context of nervous system function and the body's response to stress.[1,15]

Matcha also contains caffeine, the concentration of which depends, among other factors, on the raw material and the method of product preparation.[1,4] In the context of cognitive function, the simultaneous presence of caffeine and L-theanine may be relevant; however, based on the available evidence, not all observed effects can be attributed exclusively to this combination.[2,4,15]

Other constituents of matcha include chlorophylls, carotenoids, rutin, quercetin, and selected vitamins and minerals.[1,4,20] Their concentrations may vary between products; therefore, the mass of powder consumed alone does not always provide an accurate estimate of actual exposure to bioactive compounds.[4]

Fluoride content is another relevant aspect of matcha quality. A study by Jakubczyk et al. demonstrated that fluoride concentrations in both powder and infusions depend on harvesting time and the temperature of the water used to prepare the beverage.[21] This finding suggests that evaluation of matcha should consider not only potential benefits associated with polyphenols but also the mineral composition of the product.[21]

4.3. Matcha versus conventional green tea

The most important difference between matcha and conventional green tea lies in the manner of consumption. In conventional green tea, most of the insoluble fraction of the leaf remains outside the beverage, whereas in matcha the entire powdered raw material is consumed.[1,3,4]

This may increase the amount of catechins, caffeine, L-theanine, and other constituents of leaf tissue that are ingested.[1,3] However, this does not mean that all constituents are completely bioavailable. Polyphenols undergo digestion, metabolism, and transformation by the gut microbiota; therefore, the amount of a compound present in the product is not equivalent to the amount that is biologically active within the body.[3,4]

5. Potential mechanisms underlying the biological effects of matcha

5.1. Antioxidant activity

Among the most consistently reported experimental properties of matcha is its antioxidant capacity.[1,4,20] This activity is attributed primarily to the presence of catechins and other polyphenols.[1,3,4]

Studies examining the chemical composition and antioxidant activity of matcha have demonstrated a high capacity of matcha infusions to neutralize free radicals, although the measured values depended, among other factors, on water temperature and harvesting time.[20]

These findings confirm that the properties of the product are strongly dependent on its technological characteristics.[4,20]

Importantly, laboratory measurements of antioxidant activity should not be equated with demonstrable antioxidant effects in humans. Polyphenols are metabolized in the gastrointestinal tract and liver, and their metabolites may differ in their properties from those of the compounds present in the original product.[3,4]

Accordingly, the antioxidant capacity observed experimentally provides a rationale for further investigation, but in itself it cannot be regarded as evidence that matcha prevents specific diseases.[2,4,5]

5.2. Modulation of inflammatory processes

Catechins, including EGCG, may interact with pathways involved in inflammatory responses and oxidative stress.[1,2,4,5] However, evidence concerning these effects is derived to a considerable extent from experimental studies.

Of particular relevance are the findings reported by Zhou et al., who investigated the effect of matcha on obesity-associated hypothalamic inflammation.[22] In mice fed a high-fat diet, matcha supplementation limited body-weight gain, adipose tissue accumulation, disturbances in glucose and lipid metabolism, and excessive microglial activation in the hypothalamic arcuate nucleus.[22]

In cellular studies, matcha extract reduced the release of pro-inflammatory cytokines and the expression and phosphorylation of JAK2 and STAT3.[22] These findings indicate a possible role of this pathway in the observed anti-inflammatory effects; however, the relevance of this mechanism in humans has not been established.[22]

5.3. Polyphenol bioavailability and the role of the gastrointestinal tract

A central consideration when interpreting studies of matcha is the bioavailability of its constituents.[3,4] Catechins undergo transformations within the gastrointestinal tract, and some reach the colon, where they may be metabolized by intestinal microorganisms.[3]

Consequently, biological effects may depend not only on the amount of catechins consumed but also on interindividual differences in the composition and function of the gut microbiota.[3,12] This phenomenon may be one factor explaining differences between clinical study outcomes.

Accordingly, contemporary research increasingly considers matcha as a complex food matrix rather than simply a vehicle for EGCG.[3-5]

6. Matcha, metabolism, obesity, and the gut-liver axis

6.1. Obesity and energy metabolism

The effects of matcha on energy metabolism are among the most frequently investigated areas of preclinical research.[2,4,11-13] Animal studies have demonstrated reduced body-weight gain, decreased adipose tissue accumulation, and favourable changes in selected metabolic parameters.[11-13,19,22]

In a study by Wang et al., mice fed a high-fat diet received a diet supplemented with 1% matcha for eight weeks.[13] Supplementation limited the development of obesity, lipid accumulation, and hepatic steatosis.[13] At the same time, changes were observed in the composition of the gut microbiota, the bile acid profile, and the expression of genes involved in glucose, lipid, and bile acid metabolism.[13]

Similar findings were reported by Luo et al. using a high-fat diet-induced obesity model in mice.[12] Matcha limited increases in body weight and adipose tissue, improved glucose tolerance, and affected total and LDL cholesterol concentrations.[12] It also altered the structure of the gut microbiota and the profile of intestinal metabolites.[12]

An important component of this study was the correlational analysis linking bacteria, metabolites, and the metabolic phenotype.[12] It should nevertheless be emphasized that correlation does not establish a causal relationship. The findings should therefore be regarded as supporting the hypothesis that the microbiota contributes to the effects of matcha rather than as definitive confirmation of this mechanism.[12]

6.2. Fat oxidation during exercise

Human data are considerably more limited, but nevertheless of interest. In the study by Willems et al., 13 women consumed three beverages containing 1 gram of matcha each on the day preceding the trial, followed by another beverage 2 hours before a 30-minute brisk walk.[7] Matcha consumption was associated with a lower respiratory exchange ratio and increased fat oxidation during exercise.[7]

The study used a randomized crossover design, which increases its methodological value.[7] At the same time, its small sample size and short observation period mean that the finding cannot be interpreted as evidence of a long-term weight-loss effect.[7]

An increase in fat oxidation during a single exercise session is not equivalent to a long-term reduction in adipose tissue mass. The authors themselves cautioned against overestimating the metabolic significance of this effect within weight-reduction programmes.[7]

6.3. Matcha and glucose and lipid metabolism

Experimental studies indicate that matcha may affect glucose and lipid metabolism.[11-13,19,22] In animal models, improved glucose tolerance, reduced lipid concentrations, and attenuation of changes associated with diet-induced obesity have been observed.[12,13,22]

Chong et al. used a rat model of cafeteria-diet-induced NAFLD.[19] The animals received either a control diet or a cafeteria diet supplemented with 0.2% or 1% matcha for 12 weeks.[19] Supplementation attenuated some disturbances in lipid metabolism, insulin resistance, and inflammation and was associated with reduced visceral adipose tissue.[19]

Changes in the gut microbiota were also observed, including an increased relative abundance of selected bacterial genera such as *Akkermansia*, *Parabacteroides*, and *Faecalibacterium*.[19] These findings suggest the possibility of concurrent metabolic and microbiological changes; however, because the study was conducted in animals, the results cannot be directly extrapolated to patients with MASLD.[11,19]

6.4. Matcha and MASLD

Metabolic dysfunction-associated steatotic liver disease is a particularly interesting area in research on the potential effects of matcha. The review by Kosik-Bogacka and Piotrowska, which covers studies of matcha and tea catechins, indicates possible beneficial effects on body weight, lipid profile, glucose metabolism, and liver function.[11]

At the same time, an important distinction must be maintained between studies investigating whole matcha and those using green tea extracts or isolated EGCG.[11] A result obtained for an isolated constituent cannot automatically be attributed to the entire food product.[4,11]

In animal models, the effects of matcha on hepatic steatosis have been relatively consistent.[13,19] In the study by Wang et al., supplementation reduced hepatic steatosis while simultaneously modifying the gut microbiota and bile acid metabolism.[13] In the study by Chong et al., improvements in selected metabolic and histopathological parameters were observed in rats with cafeteria-diet-induced NAFLD.[19]

At present, however, there is insufficient clinical evidence to regard matcha as a treatment for MASLD in humans.[11] It is most appropriate to consider it a potential component of a healthy dietary pattern, the role of which in the prevention and adjunctive management of metabolic disorders requires further investigation.[11]

6.5. The gut-liver axis and the gut microbiota

One of the most interesting aspects of contemporary matcha research is its potential influence on the gut microbiota.[3,11-13,19,23] Polyphenols may reach distal regions of the gastrointestinal tract and be metabolized by intestinal bacteria, while the resulting metabolites may interact with the host organism.[3]

In the study by Wang et al., matcha supplementation affected the composition of the microbiota, the bile acid profile, and hepatic gene expression.[13] These findings support the hypothesis that the metabolic effects of matcha may involve simultaneous effects on the intestine and liver.[13]

Luo et al. combined 16S rDNA analysis with untargeted metabolomics.[12] This approach demonstrated that matcha supplementation was accompanied by concurrent changes in the gut microbiota and intestinal metabolites.[12] This is particularly relevant because it enables not only the composition of the microbiota to be assessed but also the potential functional consequences of its alteration.

Human data are considerably less developed. In one clinical study included in a more recent review and involving 33 healthy participants, two weeks of matcha consumption was associated with changes in microbial diversity, an increased relative abundance of *Coprococcus*, and a decreased relative abundance of *Fusobacterium*.[5] This finding is of interest, but the short intervention period and small sample size limit conclusions regarding long-term metabolic consequences.[5]

In addition, a randomized crossover study examining the effects of matcha on the gut microbiota of healthy individuals has been designed; however, the publication by Takegami et al. presents the study protocol rather than its results.[23] It therefore cannot be regarded as evidence of the efficacy of matcha in modifying the human gut microbiota.[23]

7. Matcha, cognitive function, stress, and sleep

7.1. Potential neurobiological mechanisms

Interest in the effects of matcha on the nervous system stems primarily from the presence of L-theanine, caffeine, and catechins.[1,2,4,15] These substances may affect processes related to attention, alertness, and responses to stress, although their interactions remain under investigation.[2,4,15]

The observed effects should not, however, be attributed to a single compound. The complex composition of matcha means that its activity may result from the simultaneous effects of several constituents.[4,5]

In a mouse model of metabolic disturbances induced by a high-fat diet, matcha extracts attenuated impairments in memory and learning, together with associated metabolic and neuroinflammatory changes, suggesting a possible relationship between the metabolic and cognitive effects observed in preclinical studies.[24]

7.2. Cognitive function in older adults

One important clinical study is the randomized, double-blind trial by Sakurai et al., which included 61 older adults.[9] Participants consumed either a beverage containing 3 grams of powdered matcha daily or placebo for 12 weeks.[9] No clear improvement in all assessed cognitive functions was demonstrated in the study population as a whole.[9] However, a sex-stratified analysis revealed a significant improvement in MoCA score among women receiving matcha.[9] This finding may suggest a potential beneficial effect in a specific subgroup, but it does not justify the conclusion that matcha universally improves cognitive function in older adults.[9]

More long-term data were provided by the study of Uchida et al., in which 99 older adults with subjective cognitive decline or mild cognitive impairment received either 2 grams of matcha daily or placebo for 12 months.[8] No significant improvement was demonstrated in the primary MoCA or ADCS-MCI-ADL outcomes.[8] At the same time, a significant improvement was observed in social emotion recognition, described as social acuity.[8] There was also a trend toward improved sleep quality assessed using the PSQI, although this result did not reach the prespecified level of statistical significance.[8]

Comparison of the two studies suggests that any potential effects of matcha may concern selected components of cognitive functioning rather than global cognitive performance.[8,9] The absence of a clear improvement in MoCA scores in the 12-month study is an important argument against claiming that matcha prevents general cognitive decline.[8]

7.3. Attention and response to stress

Baba et al. assessed the effects of consuming 2 grams of matcha daily for two weeks in 42 young adults.[14] Following the Uchida-Kraepelin test, used to induce mild acute psychological stress, attention, memory, and emotion recognition were assessed, among other parameters.[14] The matcha group demonstrated a shorter reaction time in the Stroop test and a higher number of correct responses in the emotion-recognition test.[14] No significant differences were observed in the other tests analysed.[14]

These findings suggest that the potential effects of matcha may be more apparent under conditions of psychological load than during assessment of general cognitive performance.[14]

7.4. Matcha and psychological stress

The potential stress-reducing effects of matcha have been investigated both in animal models and in humans.[15] Unno et al. demonstrated that the reduction in stress responses depended on the chemical composition of matcha, particularly its L-theanine and arginine content and the ratios of caffeine and EGCG to these constituents.[15] In a clinical study involving 39 participants, consumption of matcha with a predicted favourable compositional profile was associated with lower stress-related anxiety than placebo.[15]

At the same time, this study highlights the issue of product standardization. Different matcha samples may have substantially different profiles of bioactive constituents, which may influence the biological effect observed.[4,15]

7.5. Sleep quality and psychological well-being

Baba et al. conducted a randomized placebo-controlled study in healthy individuals aged 27-64 years who consumed 2.7 grams of matcha daily for four weeks.[10] This dose contained 50.3 milligrams of L-theanine, 301.4 milligrams of catechins, and 71.5 milligrams of caffeine.[10] No significant differences between the matcha and placebo groups were demonstrated in total sleep time, sleep latency, wake time after sleep onset, or sleep efficiency assessed by EEG.[10] At the same time, there was a tendency toward greater satisfaction with sleep duration and a shorter time required to become fully alert after awakening.[10]

These findings are important because they demonstrate that subjective perceptions of sleep quality may differ from objective measures of sleep architecture.[10] It therefore cannot currently be concluded that matcha improves sleep through a significant alteration of its electrophysiological structure.[10]

7.6. Antidepressant-like effects - preclinical evidence

Kurauchi et al. investigated the effects of matcha in a mouse model of depression involving social-isolation stress.[25] Matcha reduced immobility time in the tail suspension test in stress-susceptible C57BL/6J mice, whereas this effect was not observed in BALB/c mice.[25] Administration of a dopamine D1 receptor antagonist abolished the observed effect, while matcha administration increased the number of c-Fos-positive cells in the prefrontal cortex and nucleus accumbens.[25] These findings suggest possible involvement of the dopaminergic system in the observed effect.[25]

This result should not, however, be equated with demonstrated antidepressant activity in humans. The study was conducted in mice, and the model assesses behaviour described as "antidepressant-like", which is not equivalent to a clinical diagnosis of depression.[25]

8. Matcha, physical activity, and fatigue

The study by Shigeta et al. examined the effects of regular matcha consumption during resistance training.[6] Healthy, previously untrained men received a beverage containing 1.5 grams of matcha twice daily and participated in a training programme lasting 8 or 12 weeks.[6] In the first study, after one week of training, participants receiving matcha reported less post-exercise fatigue than those in the placebo group.[6] In the 12-week study, a greater change in muscle mass in response to training and lower salivary cortisol concentrations were observed in the matcha group.[6]

Microbiota analysis additionally demonstrated changes in five bacterial genera, and changes in *Ruminococcus*, *Butyricimonas*, and *Oscillospira* correlated with changes in maximal muscular strength.[6]

These findings are of interest because they suggest the possibility of simultaneous effects of matcha on fatigue, stress responses, the gut microbiota, and training adaptation.[6] They should not, however, be interpreted as evidence that matcha increases physical performance or muscle mass in the general population. The studies included a small group of healthy men, and some findings were statistical trends rather than definitive effects.[6]

9. Potential applications of matcha in dentistry

9.1. Matcha and *Porphyromonas gingivalis*

One of the most interesting and relatively new areas of research concerns the potential use of matcha in dentistry.[16-18]

Nakao et al. demonstrated that matcha extract inhibited the growth of *Porphyromonas gingivalis* and also affected its ability to adhere and survive.[16] The activity was multimodal and included, among other effects, changes in bacterial membrane properties and interference with mechanisms associated with fimbrial adhesion.[16]

The extract also inhibited the growth of *Prevotella nigrescens* and *Fusobacterium nucleatum*, while it did not exhibit comparable activity against some of the oral bacteria examined, including many oral streptococci.[16]

Particularly noteworthy is that the study also included a pilot clinical intervention using a matcha-containing mouthwash in patients with periodontitis.[16] A significant reduction in the number of *Porphyromonas gingivalis* in saliva was demonstrated, whereas improvement in periodontal pocket depth was only a trend and did not reach statistical significance.[16]

These findings provide an interesting bridge between laboratory and clinical research, but they are not yet sufficient to consider matcha a standard treatment for periodontitis.[16]

9.2. Matcha and gingival health

The study by Gadekar et al. compared a mouthwash containing matcha extract with 2% chlorhexidine gluconate in 32 adult patients with mild-to-moderate gingivitis and periodontitis.[17]

Following mouthwash use, improvements were observed in the assessed periodontal parameters, and within this particular study the results for the matcha mouthwash were comparable with those obtained using 2% chlorhexidine.[17] In laboratory testing, the extract also demonstrated activity against *Porphyromonas gingivalis* and *Streptococcus mutans*.[17]

This finding is of interest, but it should not be interpreted as evidence that matcha is an equivalent substitute for chlorhexidine in every clinical situation. The study had a small sample size, a short follow-up period, and concerned a specific preparation.[17]

More recent data were provided by the study of Abood et al., in which 27 adults with localized gingivitis consumed matcha twice daily for 30 days.[18] After one month, reductions in plaque index, bleeding on probing, and salivary 8-OHdG concentrations were observed in the study population as a whole.[18]

This study suggests a potentially beneficial effect of regular matcha consumption on selected parameters of gingival health and oxidative stress; however, because of its pilot nature and the absence of an appropriately matched control group, the findings require confirmation in larger randomized trials.[18]

9.3. Implications for the future of periodontology

The combination of antimicrobial, antioxidant, and potentially anti-inflammatory activity makes matcha an interesting source of compounds for further periodontal research.[5,16-18]

The most promising direction appears to be not the use of uncharacterized matcha powder itself, but the development of standardized preparations containing defined concentrations of catechins and other active constituents.[4,5]

Future studies would particularly benefit from direct comparisons of standardized matcha preparations with placebo and standard antiseptic agents, while simultaneously assessing clinical and microbiological parameters and markers of inflammation. [4,16-18]

10. Other potential biological properties

10.1. Angiogenesis

Iwai et al. investigated the effects of matcha and selected constituents on angiogenic potential.[26] In aortic ring and capillary-structure formation assays, matcha, as well as vitamin K1 and lutein present in matcha, increased angiogenic potential in the models used.[26] In mice, long-term matcha consumption was associated with preservation of capillary density in a restricted layer of the cerebral cortex during ageing.[26]

These findings are of interest from the perspective of vascular biology; however, they do not demonstrate that matcha consumption prevents vascular disease or dementia in humans.[26]

10.2. Anticancer potential

Green tea catechins, particularly EGCG, have been the subject of numerous studies investigating potential anticancer effects.[1,2,4] Experimental models have demonstrated effects of catechins on cell proliferation, apoptosis, oxidative stress, and angiogenesis.[1,4]

Evidence concerning matcha itself is considerably more limited than the evidence concerning green tea or isolated catechins.[2,4] The review by Sokary et al. emphasizes that evidence for anticancer activity of matcha remains insufficient and is derived largely from laboratory studies.[2] There is therefore no basis for concluding that matcha consumption prevents or treats cancer.

10.3. Activity against *Streptococcus pneumoniae*

Sasagawa et al. demonstrated that matcha exhibits bactericidal activity against *Streptococcus pneumoniae* under laboratory conditions.[27] The study also demonstrated inhibition of the functional activity of pneumolysin through interference with its oligomerization.[27]

These are interesting findings from the perspective of the potential antimicrobial properties of matcha; however, it should be emphasized that the study was experimental and does not provide a basis for recommending matcha for the prevention or treatment of pneumococcal infections.[27]

11. Product quality, standardization, and safety

One of the most important methodological problems in matcha research is the substantial variability in the chemical composition of the product.[4] Its profile is influenced by, among other factors, plant variety, cultivation conditions, shading, harvesting time, processing, and storage.[1,4,20]

Consequently, two matcha samples of identical mass may provide different amounts of EGCG, other catechins, L-theanine, and caffeine.[4] This issue is particularly important in clinical studies, in which exposure is often characterized solely by the mass of powder consumed.[4] The review by Phuah et al. indicates that the use of chemometric and multi-omics methods may in the future facilitate quality control and the linking of a product's chemical profile with its biological properties.[4]

Bioavailability is another important issue. A high polyphenol content in the product does not mean that all of these compounds will be absorbed in their unchanged form.[3,4]

Mineral constituents should also be taken into account. The study on fluoride demonstrated relatively high concentrations of this element in both matcha powder and infusions, with levels depending on harvesting time and water temperature.[21]

This does not mean that typical matcha consumption is inherently unsafe, but it demonstrates that product assessment should consider both potential benefits and exposure to individual mineral constituents.[21]

12. Discussion

The analysis indicates that matcha is a product with an exceptionally complex biological profile. The presence of catechins, L-theanine, caffeine, chlorophylls, and other polyphenols provides the basis for numerous experimental observations concerning its potential effects.[1,2,4,5]

At the same time, the available evidence is clearly heterogeneous. The most consistent findings have been obtained in laboratory studies and animal models, particularly with respect to oxidative stress, inflammatory processes, and metabolic disturbances.[2,4,11-13,19,22]

Human data should be interpreted considerably more cautiously. In the field of cognitive function, available randomized studies indicate the possibility of effects on selected parameters but do not demonstrate a clear global improvement in cognitive function.[8,9,14] Particularly important is the absence of a significant improvement in MoCA in the 12-month study by Uchida et al.[8]

A similar pattern is observed with regard to sleep. The study by Baba et al. did not demonstrate changes in basic sleep parameters recorded by EEG, although some signals concerning subjective sleep quality and functioning after awakening were observed.[10]

The effect of matcha on the body's response to stress appears more promising. Findings by Unno et al. indicate that an appropriately characterized product may reduce subjective anxiety responses to stress[15], whereas the study by Baba et al. suggests preservation of attentional function following mild psychological stress[14].

In the metabolic field, particularly interesting is the consistency among several animal models concerning obesity, hepatic steatosis, the gut microbiota, and lipid metabolism.[12,13,19] On this basis, it may be hypothesized that the effects of matcha are more complex than direct actions of catechins on host metabolism.

The gut-liver axis may be of particular importance. Wang et al. demonstrated concurrent changes in the microbiota, bile acid metabolism, and hepatic gene expression[13], whereas Luo et al. combined microbiota analysis with metabolomics, identifying the simultaneous occurrence of microbiological and metabolic changes[12]. At this stage, however, it cannot be concluded that the microbiota is a necessary mechanism underlying the effects of matcha. Correlations between changes in the microbiota and the metabolic phenotype do not establish causality.[12]

In this context, the development of studies that simultaneously use microbiota sequencing, metabolomics, and analysis of clinical parameters is particularly valuable.[4,12,13] Such an approach may eventually determine whether specific microbiota profiles predispose individuals to a greater response to matcha consumption.

Dental research is another relatively new and potentially important area. Demonstration of the multimodal activity of matcha against *Porphyromonas gingivalis*, together with initial clinical data on mouthwashes and matcha consumption, suggests the possibility of using its constituents in the prevention of periodontal disease.[16-18]

At the same time, standardization of the preparation is particularly important in dentistry. Findings obtained with an extract of a defined concentration cannot automatically be extrapolated to an ordinary matcha beverage.[4,16] Similarly, a result obtained with one specific mouthwash does not mean that every product containing matcha will exhibit comparable activity.

It is also important to distinguish between studies of the whole product and studies of isolated constituents. EGCG is one of the best-characterized compounds in matcha, but its effects do not necessarily correspond to those of the entire food matrix.[4,5] For this reason, it appears particularly important to develop studies in which, in addition to the dose of matcha, the actual concentrations of the principal bioactive constituents are measured.[4] Such an approach may help explain why studies using similar amounts of powder sometimes produce different outcomes.

Another limitation is the small sample size of some clinical studies. Small study populations increase the risk of chance findings and limit the generalizability of results to the wider population.[2,4,11]

A further limitation is the short duration of follow-up. Even if matcha alters a particular metabolic or cognitive parameter over several weeks, this does not automatically imply a sustained clinical benefit.[8-10,14]

With regard to metabolic health, three levels of evidence should therefore be distinguished: biological activity demonstrated in vitro, an effect observed in animal models, and a clinically meaningful effect in humans. At present, matcha is supported by substantial evidence at the first two levels, whereas evidence at the highest level remains limited.[2,4,11]

A similar situation applies to potential anticancer and neurobiological effects. The mechanisms are biologically interesting, but their clinical significance remains undetermined.[1,2,4]

In light of the available evidence, the most appropriate approach is therefore to regard matcha as a potentially functional food rather than a therapeutic agent. Its potential may be particularly relevant within dietary strategies aimed at maintaining metabolic health, supporting cognitive function, and reducing exposure to factors associated with oxidative stress.[2,4,5]

12.1. Directions for future research

Future studies should primarily use standardized matcha preparations with precisely characterized chemical composition.[4,5] Determination of EGCG, other catechins, L-theanine, caffeine, and other relevant constituents is recommended.[4]

A second priority should be larger and longer-term randomized clinical trials. Studies involving individuals with obesity, impaired carbohydrate metabolism, MASLD, or mild cognitive impairment are particularly warranted.[8,11]

A third direction is the integration of conventional clinical parameters with microbiota and metabolome analyses.[4,12,13] This would help determine whether microbiota changes are a cause or a consequence of metabolic changes associated with matcha consumption.

In dentistry, clinical studies using standardized extracts are warranted, including assessment of plaque indices, bleeding on probing, periodontal pocket depth, the abundance of periodontal pathogens, and markers of oxidative stress and inflammation.[16-18]

Direct comparisons of matcha with conventional green tea and preparations containing isolated catechins would also be particularly informative. Such studies could determine whether the potential properties of matcha result primarily from the greater intake of compounds characteristic of green tea or from their specific co-occurrence within the powdered whole leaf.[1,3,4]

13. Conclusion

Matcha is a food product with a complex chemical composition, containing catechins, EGCG, L-theanine, caffeine, chlorophylls, and other bioactive compounds.[1,2,4,5] Its specific production technology and consumption of the entire powdered leaf distinguish it from conventional green tea infusions.[1,3,4,28]

Available studies confirm the high antioxidant potential of matcha and provide substantial evidence concerning the possible effects of its constituents on inflammatory, metabolic, and neurobiological processes.[1,2,4,5,20]

An important emerging question in metabolic research is whether matcha affects the gut microbiota and the gut–liver axis.[11-13,19] Animal studies indicate the potential to limit body-weight gain, lipid accumulation, and hepatic steatosis; however, the relevance of these findings to humans requires confirmation in larger clinical studies.[11-13,19]

Clinical data concerning cognitive function suggest that matcha may beneficially affect selected aspects of cognitive performance, attention, and responses to stress, but do not support a universal cognition-enhancing effect.[8,9,14] Similarly, no clear improvement in objective sleep parameters assessed by EEG has been demonstrated.[10]

Potential applications of matcha in dentistry represent another interesting area. Findings concerning *Porphyromonas gingivalis* and initial clinical studies of mouthwashes and matcha consumption suggest a possible beneficial effect on selected periodontal health parameters.[16-18] However, the evidence remains too limited to consider matcha a substitute for standard periodontal care.

The principal limitation of the current evidence base is the heterogeneity of products, doses, and research methods, together with the predominance of preclinical studies over high-quality clinical trials.[2,4,11] An additional issue is the limited bioavailability of some polyphenols and their metabolism, which is influenced, among other factors, by the gut microbiota.[3,4]

Based on the present analysis, matcha can be considered to have a well-supported health-promoting potential, but the strength of evidence for individual effects is uneven. At present, it is most appropriate to regard matcha as a potentially functional dietary component rather than a therapeutic agent.[2,4,5]

Future research should clarify which constituents of matcha are responsible for particular biological effects, what dose is required to elicit them, in which populations these effects are most apparent, and whether microbiota changes represent one of the mechanisms underlying the product's activity.[3,4,12,13]

Taken together, the current evidence supports continued investigation of matcha at the interface of nutrition, metabolomics, microbiology, neurobiology, and dentistry; however, future clinical conclusions should be based primarily on large, long-term, appropriately standardized studies involving human participants.

Author's Contribution

Conceptualization: Dominika Joanna Duczmal-Zowczak

Methodology: Dominika Joanna Duczmal-Zowczak, Tomasz Zowczak, Jakub Tomasz Duczmal

Writing - rough preparation: Dominika Joanna Duczmal-Zowczak, Tomasz Zowczak, Jakub Tomasz Duczmal, Maciej Kalita, Natalia Krajewska

Writing - review and editing: Dominika Joanna Duczmal-Zowczak, Tomasz Zowczak, Jakub Tomasz Duczmal, Maciej Kalita, Natalia Krajewska

Supervision: Dominika Joanna Duczmal-Zowczak

Funding

No external funding was received.

Institutional Review Board Statement

Not applicable

Informed Consent Statement

Not applicable

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Acknowledgements

None

Conflicts of Interest

The authors declare no conflicts of interest.

Declaration of the use of generative AI and AI-assisted technologies in the writing process.

During the preparation of this work, the author(s) used Gemini, ChatGPT and NotebookLM for the purpose of assistance in refining the academic English language of the manuscript, ensuring clarity, consistency, and adherence to scientific writing standards. AI were used for additional linguistic refinement of the research manuscript, ensuring proper English grammar, style, and clarity in the presentation of results. After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the substantive content of the publication.

References

1. Kochman J, Jakubczyk K, Antoniewicz J, Mruk H, Janda K. Health benefits and chemical composition of matcha green tea: a review. Molecules. 2021;26(1):85. doi:10.3390/molecules26010085.
2. Sokary S, Al-Asmakh M, Zakaria Z, Bawadi H. The therapeutic potential of matcha tea: a critical review on human and animal studies. Curr Res Food Sci. 2023;6:100396. doi:10.1016/j.crfs.2022.11.015.
3. Ye JH, Liang YR, Fang QT, Zeng L, Liu RY, Lu L, et al. A comprehensive review of matcha: production, food application, potential health benefits, and gastrointestinal fate of main phenolics. Crit Rev Food Sci Nutr. 2024;64(22):7959-7980. doi:10.1080/10408398.2023.2194419.
4. Phuah YQ, Chang SK, Ng WJ, Lam MQ, Ee KY. A review on matcha: chemical composition, health benefits, with insights on its quality control by applying chemometrics and multi-omics. Food Res Int. 2023;170:113007. doi:10.1016/j.foodres.2023.113007.

5. Sławińska P, Raczkowska E. Matcha as a source of bioactive compounds: a review of health-promoting properties and potential applications. Nutrients. 2026;18(10):1613. doi:10.3390/nu18101613.
6. Shigeta M, Aoi W, Morita C, Soga K, Inoue R, Fukushima Y, et al. Matcha green tea beverage moderates fatigue and supports resistance training-induced adaptation. Nutr J. 2023;22(1):32. doi:10.1186/s12937-023-00859-4.
7. Willems MET, Şahin MA, Cook MD. Matcha green tea drinks enhance fat oxidation during brisk walking in females. Int J Sport Nutr Exerc Metab. 2018;28(5):536-541. doi:10.1123/ijsnem.2017-0237.
8. Uchida K, Meno K, Korenaga T, Liu S, Suzuki H, Baba Y, et al. Effect of matcha green tea on cognitive functions and sleep quality in older adults with cognitive decline: a randomized controlled study over 12 months. PLoS One. 2024;19(8):e0309287. doi:10.1371/journal.pone.0309287.
9. Sakurai K, Shen C, Ezaki Y, Inamura N, Fukushima Y, Masuoka N, et al. Effects of Matcha Green Tea Powder on Cognitive Functions of Community-Dwelling Elderly Individuals. Nutrients. 2020;12(12):3639. doi:10.3390/nu12123639.
10. Baba Y, Takihara T, Okamura N. Matcha does not affect electroencephalography during sleep but may enhance mental well-being: a randomized placebo-controlled clinical trial. Nutrients. 2024;16(17):2907. doi:10.3390/nu16172907.
11. Kosik-Bogacka DI, Piotrowska K. Influence of matcha and tea catechins on the progression of metabolic dysfunction-associated steatotic liver disease (MASLD) - a review of patient trials and animal studies. Nutrients. 2025;17(15):2532. doi:10.3390/nu17152532.
12. Luo Y, Wen Y, Huang J, Chen B, Lv S, Qiu H, et al. Matcha alleviates obesity by modulating gut microbiota and its metabolites. Curr Res Food Sci. 2024;9:100823. doi:10.1016/j.crfs.2024.100823.
13. Wang Y, Yu Y, Ding L, Xu P, Zhou J. Matcha green tea targets the gut-liver axis to alleviate obesity and metabolic disorders induced by a high-fat diet. Front Nutr. 2022;9:931060. doi:10.3389/fnut.2022.931060.
14. Baba Y, Kaneko T, Takihara T. Matcha consumption maintains attentional function following a mild acute psychological stress without affecting a feeling of fatigue: a randomized placebo-controlled study in young adults. Nutr Res. 2021;88:44-52. doi:10.1016/j.nutres.2020.12.024.

15. Unno K, Furushima D, Hamamoto S, Iguchi K, Yamada H, Morita A, et al. Stress-reducing function of matcha green tea in animal experiments and clinical trials. Nutrients. 2018;10(10):1468. doi:10.3390/nu10101468.
16. Nakao R, Takatsuka A, Mandokoro K, Narisawa N, Ikeda T, Takai H, et al. Multimodal inhibitory effect of matcha on Porphyromonas gingivalis. Microbiol Spectr. 2024;12(7):e0342623. doi:10.1128/spectrum.03426-23.
17. Gadekar AV, Dodamani AS, Vishwakarma PK, Agrawal AS, Wankhede SD, Tadas ST. Comparative evaluation of herbal Matcha extract and 2% chlorhexidine gluconate on periodontal health status: a clinico-microbiological study. J Contemp Dent Pract. 2025;26(5):488-492. doi:10.5005/jp-journals-10024-3880.
18. Abood RS, Al-Taweel FBH, Akram HM, Abdulbaqi HR. Does daily intake of matcha tea enhance the periodontal health of patients with localised gingivitis: a control study. Oral Health Prev Dent. 2025;23:535-541. doi:10.3290/j.ohpd.c_2268.
19. Chong HC, Tang ST, Tseng YC, Yang SC, Watanabe Y, Yamada S, et al. Matcha green tea improves cafeteria-diet-induced NAFLD by modulating the gut microbiota in rats. Nutrients. 2025;17(19):3051. doi:10.3390/nu17193051.
20. Jakubczyk K, Kochman J, Kwiatkowska A, Kałduńska J, Dec K, Kawczuga D, et al. Antioxidant properties and nutritional composition of matcha green tea. Foods. 2020;9(4):483. doi:10.3390/foods9040483.
21. Jakubczyk K, Ligenza A, Gutowska I, Janda-Milczarek K. Fluoride content of matcha tea depending on leaf harvest time and brewing conditions. Nutrients. 2022;14(12):2550. doi:10.3390/nu14122550.
22. Zhou J, Lin H, Xu P, Yao L, Xie Q, Mao L, et al. Matcha green tea prevents obesity-induced hypothalamic inflammation via suppressing the JAK2/STAT3 signaling pathway. Food Funct. 2020;11(10):8987-8995. doi:10.1039/D0FO01500H.
23. Takegami M, Hamaguchi M, Miyoshi T, Munekawa C, Yoshimura T, Nakajima H, et al. Effect of matcha consumption on gut microbiota in healthy Japanese individuals: study protocol for a double-blind crossover interventional study. J Clin Biochem Nutr. 2022;70(3):262-265. doi:10.3164/jcbn.21-110.
24. Kim JM, Lee U, Kang JY, Park SK, Kim JC, Heo HJ. Matcha improves metabolic imbalance-induced cognitive dysfunction. Oxid Med Cell Longev. 2020;2020:8882763. doi:10.1155/2020/8882763.
25. Kurauchi Y, Ohta Y, Matsuda K, Sanematsu W, Devkota HP, Seki T, et al. Matcha tea powder's antidepressant-like effect through the activation of the dopaminergic system

in mice is dependent on social isolation stress. Nutrients. 2023;15(3):581. doi:10.3390/nu15030581.

26. Iwai R, Ishii T, Fukushima Y, Okamoto T, Ichihashi M, Sasaki Y, et al. Matcha and its components control angiogenic potential. J Nutr Sci Vitaminol (Tokyo). 2021;67(2):118-125. doi:10.3177/jnsv.67.118.
27. Sasagawa K, Domon H, Sakagami R, Hirayama S, Maekawa T, Isono T, et al. Matcha green tea exhibits bactericidal activity against Streptococcus pneumoniae and inhibits functional pneumolysin. Antibiotics (Basel). 2021;10(12):1550. doi:10.3390/antibiotics10121550.
28. Ziemińska J, Małek M, Wojtaszek O, Skowron A, Orzeł J, Przygoda A, et al. Matcha - an ordinary tea or a superfood with remarkable health benefits? A review of human and animal studies. Qual Sport. 2026;65:73802. doi:10.12775/QS.2026.65.73802.