Health influence of yerba mate (*Ilex paraguariensis)- literature review*

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Conflicts of Interest

The authors declare no conflict of interest.

Abstract:

Background: Yerba mate (*Ilex paraguariensis*) is a culturally significant infusion with proposed cardiometabolic, neurobehavioral, bone, renal, and safety-relevant effects. We synthesized contemporary evidence across study designs to clarify health impacts and research needs.

Methods: Narrative review of PubMed and Scopus using “yerba mate health” and “Ilex paraguariensis health.” After deduplication, 113 records were identified; inclusion criteria were English language (or translation) and publication years 2015–2025. Primary (non-review) evidence (n=31) and recent reviews were qualitatively synthesized by domain.

Results: Small randomized trials show signals of modest cardiometabolic benefit (lower blood pressure/inflammatory mediators, selective LDL-C effects, and reduced adiposity indices), with generally null short-term effects in people with HIV. Preclinical data suggest anticancer activity in prostate models, neurobehavioral protection, bone preservation under perimenopausal oxidative stress, and mitigation of experimental nephrotoxicity. Epidemiologic syntheses associate mate with upper aerodigestive tract cancers, with very hot drinking temperature and processing-related contaminants as likely contributors. Clinically relevant safety/utility notes include inhibition of non-heme iron absorption in hereditary hemochromatosis and gastric emptying comparable to tea within standard preoperative fasting windows; sporadic quality issues (e.g., alkaloid contamination) have been reported.

Conclusions: Evidence supports plausible, context-dependent benefits tempered by safety considerations and heterogeneous methods. Definitive guidance requires larger, longer, standardized trials using analytically characterized preparations and explicit evaluation of temperature and quality-related risks.

Keywords: Ilex paraguariensis; yerba mate; cardiometabolic health; obesity; chlorogenic acids

Introduction

Yerba mate (*Ilex paraguariensis*) is a traditional South American infusion increasingly consumed worldwide and touted for diverse health effects spanning cardiometabolic protection, antioxidant and anti-inflammatory actions, neuroprotection, weight management, and microbiome modulation. Mechanistically, mate provides a complex matrix of methylxanthines, saponins, and polyphenols (notably chlorogenic acids) that could influence endothelial function, lipid/glucose metabolism, redox status, and host–microbe crosstalk [1]. Within the broader *Ilex* genus, bioactive profiles and putative health benefits have been summarized, supporting interest in nutraceutical applications and comparative work with other caffeinated botanicals [2]. Reviews focused on obesity and "cardiodiabesity" underscore promising but still heterogeneous evidence, with calls for more standardized human trials to clarify efficacy, safety, doses, and mechanisms [3].

At the same time, safety controversies persist. A systematic review and meta-analysis reported higher odds of upper aerodigestive tract cancers among mate drinkers, particularly at high volumes, while a quantitative risk assessment suggested beverage temperature—rather than polycyclic aromatic hydrocarbons (PAHs)—is the dominant esophageal cancer hazard; PAH content in dried leaves can be high but infusion transfer varies widely, and modeled margins of exposure for PAHs were reassuring compared with "very hot" temperature risks [4]. Additional safety considerations include occasional detection of plant alkaloid contaminants in commercial herbal infusions and formulation-dependent toxicity signals in preclinical models [5].

Given this mix of promise and uncertainty, the present review narratively synthesizes recent human, animal, and in vitro evidence on the health impacts of yerba mate, while mapping signals against safety/risk data and reviews on mechanisms, aging, and the gut microbiome [6].

Methods

We conducted a narrative review synthesizing evidence on health-related effects of *Ilex paraguariensis* from human studies, animal models, in vitro experiments, and domain-relevant reviews. Literature searches were performed in PubMed and Scopus using the phrases "yerba mate health" and "Ilex paraguariensis health." After deduplication, the PubMed query "yerba mate health" yielded 113 unique records. Inclusion criteria were predefined as follows: articles published in English (or translated into English) and within the

last 10 years (2015–2025); original research evaluating *Ilex paraguariensis* (infusions, beverages, extracts, or defined constituents) with health-relevant outcomes in any population or experimental system; and reviews, guidelines, or risk-assessment papers used to frame mechanistic or safety context. For a supplementary synthesis focused on primary evidence, 31 non-review studies were retained. Given heterogeneity of designs, exposures, and endpoints, we undertook a qualitative (narrative) synthesis without meta-analysis, organizing findings by thematic domains (cardiometabolic/metabolic; oncology and carcinogenic risk; bone/mineral health; renal/nephroprotection; neuropsychology/exercise; and safety including iron interactions and perioperative considerations). Individual results are cited inline with full references in brackets adjacent to the corresponding text.

Results

1. Cardiometabolic outcomes

A randomized, controlled, blinded crossover trial by Bravo et al. in non-habitual consumers (healthy and hypercholesterolemic) associated eight weeks of three daily mate servings with lower blood pressure and reductions in multiple inflammatory cytokines/chemokines and colony-stimulating factors; LDL-cholesterol fell among normocholesterolemic participants, ghrelin and GIP decreased, GLP-1 and adipocytokines were unchanged, and modest decreases in adiposity indices were confined to healthy subjects without weight loss [6].

In a double-blind, placebo-controlled crossover by Gebara et al. (34 men, ~580 mg/day caffeoyl-quinic acids for 4 weeks), between-treatment differences were largely null, yet within-arm analyses suggested fasting glucose reduction, a ~10% HDL-cholesterol increase in those at higher Framingham risk, and CRP/IL-6 decreases in a representative subgroup [7].

In people with HIV receiving ART, a clinical trial by Souza et al. found that a short dark-chocolate intervention—but not mate tea—raised HDL-cholesterol, with other lipid and oxidative measures largely unchanged, tempering expectations for brief mate exposures in this setting [8].

A 12-week randomized, double-blind trial by Kim et al. in Korean adults with obesity (3 g/day capsules) demonstrated reductions in body fat mass, percent body fat, and waist–hip ratio without safety concerns [9]. Reviews on obesity/cardiodiabesity provide context for

these mixed findings and stress the need for larger, standardized human trials to resolve efficacy and dosing [3].

2. Oncology and carcinogenic risk

A murine model study by Santiano et al. reported that ad libitum mate (25 mg/mL) delayed tumor onset and reduced tumor volume; in vitro, mate decreased viability, proliferation, adhesion, and migration across several prostate cancer lines, with the most pronounced effects in androgen-sensitive LNCaP cells [10].

In contrast, a systematic review and meta-analysis by Mello et al. associated mate consumption with increased odds of upper aerodigestive tract cancers across oral, pharyngeal, esophageal, and laryngeal sites, with higher odds at >1 L/day [4]. A narrative review by Oranuba et al. highlighted consistently high PAH mass fractions in many commercial dried mates but wide variability in infusion transfer (1–50%), emphasizing the need for realistic exposure studies [11]. Complementarily, a margin-of-exposure assessment by Okaru et al. concluded that very hot beverage temperature—rather than PAH intake—likely dominates esophageal cancer risk across hot drinks, aligning with epidemiology [12]. As a mechanistic counterpoint, Bracesco et al. demonstrated in yeast that mate infusion and rutin mitigated γ-irradiation–induced DNA damage and mutagenesis, consistent with antioxidant and DNA-repair modulation [13].

3. Bone and mineral health

A rat experiment by Brun et al. showed that while low-calcium diets impaired multiple bone metrics, mate infusion did not worsen bone outcomes and partially offset trabecular bone loss; however, biomechanical properties and connectivity were not restored under calcium restriction, suggesting neutrality under adequate calcium intake with limited protection during deficiency [14]. Two perimenopausal rat studies by Pereira and colleagues reported that mate reduced oxidative stress, preserved bone microarchitecture and BMD, lowered osteoclastic activity, and shifted RANKL/OPG and antioxidant enzyme profiles toward bone conservation [15].

4. Renal and antioxidant effects

An experiment by Muccillo-Baisch et al. using a potassium-dichromate nephrotoxicity model found that 15-day chimarrão pretreatment attenuated renal oxidative stress (protein carbonyls, MDA) and that post-insult administration improved estimated GFR, consistent with nephroprotection under oxidant challenge [16].

5. Neuropsychological and exercise-related findings

A study by de Lima et al. in rats subjected to chronic restraint stress reported that whole mate extract preserved locomotor activity, normalized anxiety-like behavior, and more effectively blunted histological and neuroinflammatory alterations than isolated chlorogenic acid, suggesting multi-component synergy [17]. In mice, Ludka et al. showed antidepressant-like and neuroprotective effects of a hydroalcoholic extract mediated via NMDA-receptor and L-arginine–NO signaling; methylxanthines contributed to antidepressant-like responses but did not account for neuroprotection [18]. A small randomized, repeated-measures experiment by Alkhatib and Atcheson in active women found higher fat oxidation during 30-minute moderate cycling and improved satiety and mood ratings after mate versus placebo, indicating potential adjunctive benefits when paired with exercise at “fat-loss” intensities [19].

6. Toxicology, safety, iron interactions, and perioperative considerations

A comparative toxicity evaluation by Abrão et al. found that aqueous extracts had higher total phenols and lower in vitro cytotoxicity overall; in zebrafish embryos, the traditionally cultivated aqueous extract produced concentration-dependent developmental toxicity, whereas the organic extract showed no apparent toxicity up to 100 µg/mL and attenuated rotenone toxicity—suggesting cultivation/extraction conditions materially affect safety profiles [20].

A randomized crossover study by Pagliosa et al. in hereditary hemochromatosis showed that co-ingesting mate infusion with a test meal markedly reduced postprandial serum iron exposure versus water, indicating clinically relevant inhibition of non-heme iron absorption and a potential adjuvant role in iron overload [21].

For perioperative policy, Alcarraz et al. used gastric ultrasound to show that 300 mL of mate infusion emptied at a pace comparable to hot/cold tea, with gastric volumes back to baseline

by ~100 minutes, supporting a 2-hour clear-fluid fasting interval for mate before elective procedures [22].

Additionally, a marketplace survey by Mateus et al. reported high antioxidant capacity for yerba mate but detected tropane alkaloids above regulatory thresholds in one of seventeen herbal infusions, reinforcing the need for manufacturing oversight and analytical surveillance [5].

Discussion

This review indicates that yerba mate may confer modest cardiometabolic improvements in selected clinical contexts, alongside experimental signals for anticancer activity in prostate models, bone preservation under oxidative stress, nephroprotection, and neurobehavioral benefits; it also has clinically relevant effects on non-heme iron absorption and appears comparable to tea for preoperative gastric emptying. Nonetheless, confidence in these observations is limited by the small size, short duration, and heterogeneity of human studies, frequent reliance on surrogate biomarkers, and inconsistent reporting of preparation variables such as dose, brewing protocol, water temperature, and leaf processing that can alter both efficacy and safety. The evidence base is further constrained by our abstract-level data extraction, absence of formal risk-of-bias assessment or GRADE certainty ratings, and a search confined to PubMed and Scopus. Observational associations between mate consumption and upper aerodigestive tract cancers must be interpreted in light of confounding by very hot beverage temperature and product contaminants, which were rarely quantified in trials. A stronger evidence base will require preregistered, adequately powered randomized trials with standardized interventions and analytically characterized products, longer follow-up with clinically meaningful endpoints, explicit safety quantification, and broader, duplicate literature searches across additional databases and registries.

Conclusion

Yerba mate is a culturally important, chemically complex beverage with a health profile that is promising but not definitive. Small randomized studies suggest modest cardiometabolic benefits and reductions in adiposity measures, while preclinical work points to potential anticancer, bone-protective, renal, and neurobehavioral effects; in humans, mate can reduce non-heme iron absorption and seems acceptable within standard clear-fluid fasting guidance.

These signals are counterbalanced by epidemiologic links to upper aerodigestive tract cancers—likely influenced by very hot drinking temperatures and product quality—highlighting the importance of moderate consumption practices and careful sourcing. At present, firm clinical recommendations are premature; progress toward actionable guidance depends on larger, longer, and better-standardized trials and systematic reviews that integrate rigorous bias assessment and comprehensive safety evaluation

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