

Yerba mate (*Ilex paraguariensis*): An Underutilized Supercharged Beverage Crop Alternative to Traditional Tea for Health and Vitality

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ABSTRACT

This article explores the health benefits and potential of yerba mate (*Ilex paraguariensis*), a traditional beverage from South America, as an alternative to conventional tea. Rich in antioxidants, polyphenols, and methylxanthines, yerba mate exhibits various pharmacological activities, including anti-inflammatory, cardioprotective, and anti-diabetic properties. Its stimulating effects, attributed to caffeine, enhance mental alertness and physical performance, making it popular among athletes. The processing methods of yerba mate, including harvesting, roasting, and maturation, significantly influence its flavor and health benefits. Despite its long-standing cultural significance, scientific research on yerba mate has intensified in recent years, revealing its potential as a functional food ingredient. However, caution is advised regarding excessive consumption, particularly at high

temperatures, due to potential health risks. Continued investigation into yerba mate's properties may further establish its role in promoting health and vitality.

INTRODUCTION

Ilex paraguariensis, of the *Aquifoliaceae* family, is a tree whose leaves (*Mate folium*), after being dried and roasted, are used to prepare the Paraguayan tea known as “Yerba Mate”. The genus *Ilex* comprises about 450 species growing in the tropical regions of South America and Asia. *Ilex* trees are located exclusively in South America: in northern Argentina, southern Brazil, Uruguay, and Paraguay, where they cover an area of approximately 540,000 km². *I. paraguariensis* is a subtropical, dioecious, evergreen tree that grows from 8 to 15 m. The hard perennial leaves are 8 cm long, olive green in color, darker on top. They are egg-shaped with a wedge-shaped base, crenate edge, and blunt tip (Figure 1).



Figure 1. Oval shaped perennial Yerba Mate leaves

Paraguayan holly blooms from October to November. It has small, white, silky flowers (usually four-petaled) gathered in inflorescences at the tops of branches. It fruits from March to June. The fruit are red or reddish-brown berries 5–8 mm in diameter, containing 4–5 yellow seeds with a hard shell, which are dispersed by birds (figure 2). There is a residual embryo in many apparently ripe seeds, so that the period from sowing to germination can be long (Colpo *et al.*, 2016).



Figure 2. Reddish brown Yerba Mate berries

The tree requires high humidity throughout the year the rain-fall must not be less than 1200 mm, while is less sensitive to temperature fluctuations and can withstand even -6°C . The words “Yerba Mate” come from two languages (Spanish and Ketchua), and literally mean “herbs from the calabash”, because mate leaves were brewed in special vessels made of dried calabash fruit. The first to use Yerba Mate in its natural habitat was the Guaraní Indians. In the 16th century, the Jesuits came to this area, who not only appreciated the advantages of the drink, but soon (around 1670 years) started to professionally cultivate and trade in the leaves of the Paraguayan holly, hence the drink made from the leaves became known as Paraguayan, missionary, or Jesuit tea. The production of Yerba Mate tea in the three main countries (Argentina-the largest producer, Brazil, and Paraguay) is estimated at about 1.4 million tons per year, of which only less than 5% is exported, while the vast majority, as a national product, is destined for domestic consumption, e.g., about 80% in Brazil (Da Silveira *et al.*, 2017).



Figure 3. The inflorescence of the yerba mate plant is a group of pistils in fascicles

Yerba Mate Processing

The cultivation and harvesting of Yerba Mate are carried out in different ways depending on the region. The raw material is obtained from holly trees growing in natural conditions and from plantations or trees planted in the wild. The production process of Yerba Mate tea follows several stages, which, depending on the producer and the desired taste of the tea, differ in duration, temperature, and type of wood used for roasting and drying the product (Da Veiga *et al.*, 2018).

The production process of Yerba Mate tea includes (figure 4):

- **Raw material harvesting-** fresh (6–12-month-old) leaves and stems are harvested, packaged, and transported to the processing site
- **Roasting (blanching)-** brief (10 s to 3 min) heating at temperatures up to about 500 °C to inactivate oxidative enzymes (polyphenol oxidase), slow the natural decomposition of plant material, and preserve sensory properties. Traditionally, this process was carried out by direct exposure to an open wood or propane fire in a rotary kiln (cylinder).
- **Drying-** in order to reduce the moisture content of the leaves to 4.5%, the raw material is placed for 8–24 h in drying chambers where temperatures up to 100 °C and filtered or unfiltered smoke from the burning wood is used.
- **Maturation-** dry product is crushed and placed in cement or cedar chambers for at least 12 months to develop its specific flavor. Maturation significantly increases the concentration of certain components (methylxanthines and polyphenols) and the antioxidant activity of Yerba Mate.

- **Sieving-** separating the twigs from the leaves in order to remix them in specific proportions. The leaves are responsible for the active compounds content and the taste of the drink, while the twigs act as a kind of filter to stop dust from entering the Yerba Mate drinking tubes and reduce the price of the finished product. Different types and brands of Yerba Mate have a specific ratio of leaves and twigs. Yerba Mate Despalada is theoretically without twigs (in reality it contains up to 10% of them) while Yerba Mate Elaborada is a type of dried tea containing about 35% of twigs.
- **Packaging-** the product is crushed before packing and can be flavored with natural fruit essences, such as pomelo juice or other citrus fruits.

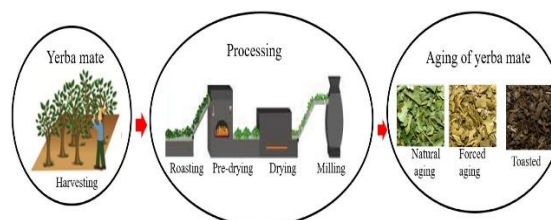


Figure 4. Processing of Yerba Mate berries

Chemical Compounds

Yerba Mate contains numerous chemical compounds, including nutrients: carbohydrates (80.71%), proteins (4.09%), and fats (0.90%). In addition, it contains numerous secondary metabolites, especially purine alkaloids (caffeine, theobromine), polyphenols (phenolic acids, flavonoids), and terpenes (saponins, carotenoids) as well as vitamins, mainly water-soluble ones in 100 g of dried leaves; about 22 mg of vitamin C; and 5.5, 1.8, and 0.7 mg of vitamin B1, B2 and B6, respectively, were determined (Garcia-Lazaro *et al.*, 2020).

Yerba mate is a notable natural source of phenolic compounds, predominantly chlorogenic acids such as caffeoylquinic, feruloylquinic, and dicaffeoylquinic acids. Regular and high consumption of yerba mate

can result in caffeine intake levels that approach those associated with coffee. For reference, a standard 150mL cup of coffee typically contains between 75mg and 330mg of caffeine (equivalent to 0.5–2.2mg/mL), whereas a 500mL serving of chimarrão provides approximately 93mg to 110mg of caffeine. This amount may increase significantly given that some individuals may consume as much as 6L of mate daily. In addition to caffeine, mate contains significant levels of theobromine, which also contributes to the total methylxanthine intake. The flavonoid content in mate is relatively low, though quercetin and rutin are among the principal flavonoids detected. The presence of kaempferol remains uncertain, largely because it is insoluble in water, making its identification in water-based extracts questionable.

Pharmacological Activity

The effect of *I. paraguariensis* beverages on the human body is also due to the presence of polyphenols with antioxidant properties and saponins, as confirmed by numerous in vitro, in vivo, and even clinical studies. Yerba Mate, as a powerful antioxidant, lowers cholesterol, prevents peroxidation and lowers lipids in the blood and tissues, so it can be used to reduce obesity, hypertension, and diabetes. It also has anti-inflammatory and antibacterial activity, and even prevents certain types of cancer. Due to its thermogenic properties, the consumption of Yerba Mate has also become very popular among athletes (Bracesco *et al.*, 2012).

Stimulating Effect

The stimulating properties of Yerba Mate have long been known to the indigenous people of South America, who regularly consume this beverage. Yerba Mate contains water soluble caffeine, which stimulates the cerebral cortex, so when used as a tonic, it relieves mental and physical fatigue, improves memory and

concentration, improves reaction time and alertness, and alleviates the negative effects of exposure to stress. In addition to stimulating the central nervous system, caffeine stimulates the heart and muscles and speeds up metabolism and oxygen uptake by body tissues, so it has a significant effect on various metabolic functions, such as the feeling of satiety, thermogenesis, and fat oxidation (Nowacki *et al.*, 2021).

Antioxidant Capacity

Green and roasted Yerba Mate extracts showed in vitro high antioxidant activity comparable to synthetic antioxidant (BHT). Additionally, the similar activity of both extracts indicates that the roasting step, although it modifies the profile of volatile and phenolic compounds in the brew, does not cause a loss of antioxidant properties. Green and roasted Yerba Mate extracts possessed strong antioxidant activity highly correlated with polyphenolic compound content similar to analogous green tea extracts.

Effects on Lipid Metabolism

Ex vivo studies low-density lipoprotein LDL obtained from human plasma before and after drinking Yerba Mate have shown that, due to the presence of antioxidants, which are absorbed into the bloodstream after consuming the drink, there is reduced oxidation of LDL, leading to a reduction in the accumulation of cholesterol in the walls of blood vessels.

Cardioprotective Effects

Consumption of Yerba Mate may affect heart function. After consumption of Yerba Mate tea, antioxidant compounds are absorbed and appear in the circulating plasma where they exert antioxidant effects. By inhibiting lipid peroxidation in individuals with elevated LDL levels, these compounds slow the progression of atherosclerosis and promote vascular relaxation. Long-term consumption of Yerba

Mate tea independent of dietary intervention increases plasma antioxidant protection in dyslipidemic patients. The polyphenol-rich Yerba Mate drink prevents the loss of anti-atherosclerotic function of HDL, and this results in an increase in the activity of the antioxidant enzyme with cardioprotective effects (Pereira *et al.*, 2017).

Anti-Diabetic Properties and Protection against Diabetic Complications

Inhibition of advanced glycation end-products (AGE) formation by aqueous extracts of Yerba Mate concentrations of the well-known anti-diabetic agent aminoguanidine, which was not exhibited by green tea. Such a strong antiglycation effect of Yerba Mate is mainly due to polyphenols: chlorogenic acid and caffeic acid, and, to the least extent, saponoside compound known as oleanolic acid. For this reason, Yerba Mate may be a natural herbal adjunct to diabetes treatment as it combines antioxidant and anti-AGE activities.

Anti-Inflammatory and Anti-Cancer Effects

Animal intervention studies have provided strong evidence for the anti-inflammatory effects of Yerba Mate, showing that intraperitoneal or oral administration of mate extracts to mice exposed to tobacco smoke significantly reduced acute lung inflammation. Administration of Yerba Mate to mice chronically exposed to tobacco smoke toxicity reversed lung lesions (fibrosis, alveolar enlargement and hemorrhage) and reduced oxidative damage in tissues.

Yerba Mate as a Functional Food Ingredient

The regular consumption of Yerba Mate beverages is categorized as functional food intake due to its antioxidant, anti-inflammatory, cardioprotective, dyslipidemia-preventing, and insulin-resistance properties.

A number of papers have reported results from preclinical and clinical studies, suggesting that Yerba Mate consumption may be an interesting food source for humans to minimize some cardiovascular risk factors (Bernardi *et al.*, 2019).

CONCLUSION

Yerba mate has a longstanding tradition of use, yet significant scientific investigation into its properties has only accelerated in the last twenty years. The surge in global popularity underscores the importance of continued research into this herbal infusion, which holds promise both as a beverage and for its applications in the nutraceutical sector. Studies suggest that drinking yerba mate can positively impact human health, with reported benefits such as liver cell protection, stimulation of the central nervous system, anti-inflammatory properties, and support for cardiovascular health. Additionally, yerba mate is commonly recommended for those seeking assistance with weight management and as a supplement during physical activity. Nevertheless, it is important to note that excessive consumption, particularly at very high temperatures, has been associated with a potential elevated risk of certain cancers, although definitive evidence is still lacking.

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