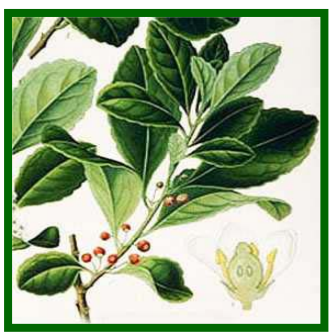
YERBA MATÉ

(Ilex paraguayensis)

"The drink of the gods"

An exceptional South American herb.



By Jorge Weil, MD ©
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DEFINITION

Yerba maté is the final commercial product obtained after drying and shredding the leaves and young twigs (with or without flower fragments) of the South American holly tree, ***Ilex paraguayensis*** **St.-Hil. (Aquifoliaceae)**. With multiple regional uses, this product, also known as *yerba* or *maté,* is well known for its use in the preparation of a non-alcoholic, stimulant decoction made by adding water to the powdered mixture. The habit of drinking maté beverages is widespread in Argentina, southern Brazil, Paraguay, Uruguay and Chile. The herb is either cultivated or exploited from native forests in the first three countries mentioned here.

BOTANICAL DESCRIPTION

Even though the Spanish common name *(yerba)* suggests that the plant is herbaceous, the raw material for this product comes from a tree. (*Yerba* is a corruption of the Spanish word *hierba*, which means “herb.”) Yerba maté is a large, dioecious tree up to 18 meters in height. Its leaves are alternate, glabrous, non-deciduous, coriaceous and obovate, with a serrate margin and obtuse apex. The inflorescences are cymose fascicles of dichasial axes; the staminate dischasia branched with up to 11 flowers each, and the pistillate ones simpler, bearing up to 3 flowers per axis. The flowers are small (corollas about 6 mm in diameter), whitish, 4- to 5-merous, and unisexual with rudimentary vestiges of the opposite sex. Fruits have dark, purple-reddish nuclei around 7 mm in diameter, each bearing usually 4 or 5 single-seeded pyrenes (i.e., propagules, commonly known as the seeds of the tree).

In South America, the flowering spring season extends from October to November for this species. Female flowers show an entomophilous pollination pattern (pollinated by insects in the orders Diptera and Hymenoptera) and pollen rarely reaches pistillate flowers further than 600 m from a male tree. Fruits are mature from the middle of February through June of each year. In wild conditions, dissemination is endozoic, performed by birds (Giberti, 1994a). There are immature rudimentary embryos in many ripe seeds, which causes a long difficult period of germination (the first plants appear 2 or more months after sowing). Precisely, this long step exposes the seeds to damage from either fungal or arthropodal attack, resulting in low germination percentages. This is one of the main reasons that yerba maté crops do not exist outside native South American environments.

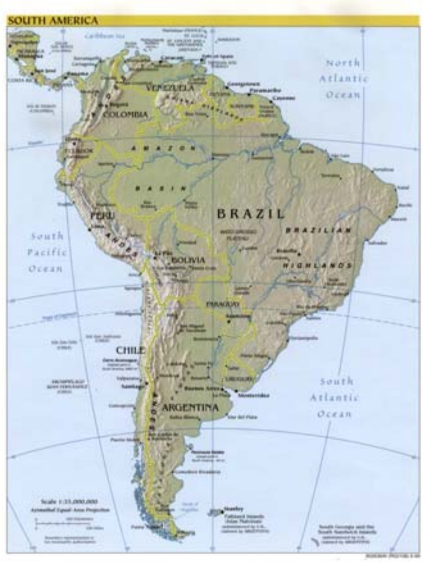
NATIVE GEOGRAPHICAL DISTRIBUTION, ECOLOGY AND AREA OF CULTIVATION

Wild *Ilex paraguayensis* grows in an extensive subtropical region that includes southwestern Brazil, northeastern Argentina (Corrientes and Misiones) and eastern Paraguay. It also exists in small disjunct areas in quasi-temperate environments in Uruguay (Giberti, 1994b).

Prominent among its ecological requirements are proper climatic conditions. The plant requires an average annual precipitation of not less than 1,200 mm per year and an even distribution of rainfall throughout the year; during the driest quarter of the year (i.e., winter), the minimum must be 250 mm of rainfall. The mean annual temperature of the area is around 21º Celsius. *I. paraguayensis* is able to tolerate absolute minimum temperatures as low as -6º Celsius, and winter snows are not infrequent in its native region (high plateaus and low mountain ranges in southern Brazil and northeastern Argentina, which may reach 1,000 to 1,200 meters above sea level). Yerba maté trees require lateric, reddish, deep, acid (pH 5.8-6.8) soils with medium to fine textures (Giberti, 1994a).

For *I. paraguayensis,* the area of cultivation and/or extractive exploitation from natural yerba maté forests (known as *yerbales nativos*) roughly coincides with the main dispersion area. Nevertheless, intensive crop procedures are concentrated in Argentina's northeastern provinces, Misiones and Corrientes.

Argentina is the world's leading producer and consumer of yerba maté. The Argentinean industrial production comes from farms where the tree is carefully cultivated and pruned, and never from the harvest of wild forest trees. Therefore, these procedures usually ensure good quality standards for the raw material.



USES

Yerba maté's main use is in the form of infusions prepared as a kind of tea made from almost powdered dried leaves and twigs that have been shredded and mixed. Leaves are sometimes toasted before shredding and mixing. Today, yerba maté is one of the most popular beverages in Argentina, Paraguay, Uruguay, and southern Brazil.

Very frequently in South American countries, the preparation of this tea is accomplished by filling small, empty gourds (*Lagenaria vulgaris* L., known as "maté gourds"), with yerba maté powder, to which water at an almost boiling temperature is gradually added. The infusion is then sucked through a metal straw with an extended sieved end (called *bombilla*). The method just described is the preparation procedure for the traditional way of drinking the bitter yerba maté infusion known as "maté amargo," but another involves the addition of sugar or alternative sweeteners to the maté gourd, resulting in a "maté dulce" (sweet) infusion. Aromatic herbs and milk are also frequently added. Other methods of consumption include "maté cocido" (prepared within tea cups), "terere" (using cold water), liqueurs, desserts, and ice creams.

PHYTOCHEMISTRY

As might be expected, yerba maté's organic components have attracted much more recent interest than its inorganic compounds. Moreover, in spite of the fact that maté is a human beverage and food component, existing knowledge about its vitamin and mineral content is out of date (Alikaridis, 1987), and some old data have been misinterpreted.

Thus, information about yerba maté's phytochemistry has remained up to now rather scant. Prominent secondary metabolites are xanthines (mainly caffeine), flavonoid glycosides (rutin), and caffeoylquinic acid derivatives (chlorogenic acids) (Schenkel, *et al.,* 1996).

It is well known that plant chemical composition, as well as much other phenotypic data, is influenced by several genetic and environmental factors. In yerba maté, such phytochemical variations were not acknowledged until quite recently. Both interclonal (genetic) differences (Bertoni, *et al*., 1991) and annual rainfall fluctuations (Bertoni, *et al.,* 1992) were observed to modify plant secondary metabolite data. It is now quite clear that chemical data from fresh leaves can be quite different from that taken by the same method from the final industrial products.

Among other valuable phytonutrients, yerba maté contains practically all of the vitamins necessary to sustain life, including vitamins A, E, B-complex, and C. In addition, it contains 15 different amino acids and significant amounts of magnesium, calcium, iron, sodium, potassium, manganese, phosphates, zinc, niacin, sulfur, chlorophyll, choline and inositol.

Xanthines

***I**lex paraguayensis* has been known to contain caffeine since 1843, when Dr. Stenhouse first described the caffeine content of the plant (Alikaridis, 1987). Dimethylated xanthines, such as theobromine (Ashihara, 1993) and theophylline (Rosovsky de Cernadas, 1983), are also present in fresh plant material, although, like the trimethylated compound, they undergo quantitative fluctuations during plant ontogeny.

Perhaps the first paper able to recognize a normal decrease in total caffeine content as young yerba maté leaves become mature was that of Weevers (1929). A similar phenomenon occurs in tea leaves (Fujimori, *et al.,* 1991). Moreover, a decrease in caffeine content of the final yerba maté product could also be related both to an increase of the twig proportion in the mixture and to a long drying period during industrial elaboration (Bertoni *et al.,* 1992). As caffeine content is considerably higher in yerba maté leaves than twigs, for the final industrial product a maximum of 30% of ground twigs is tolerated by law (De la Canal, 1980).

The xanthine biosynthetic pathway for yerba maté was not comprehensively studied until quite recently (Ashihara, 1993). It has proven to be similar to those proposed for tea. As in other plant families, neighbor *Ilex* species from the same region are unable to synthesize caffeine, including *I. brevicuspis* Reissek and *I. dumosa* Reissek (Bertoni *et al.,* 1993)

The presence of a minimum amount of caffeine (0.6%) in a sample of yerba maté final product is of great importance to characterize the genuine product. Xanthine content in yerba maté leaf may be as high as 2.5%.

Caffeine ($C_8H_{10}N_4O_2$) is an alkaloid known as trimethylxanthine. Ingestion of caffeine boosts energy and creates a sensation of well being.

In the last few years, scientists studying yerba mate's caffeine have coined the term ***matéine*** to describe the alkaloid as it occurs in yerba maté. This is based on findings that the nature of the chemical link of some minerals (like magnesium and manganese) and B-complex vitamins to the caffeine is different in yerba maté than in other caffeine-containing plants, including tea, coffee and guarana.

Dr. Jose Martin, Director of the National Institute of Technology, of Paraguay has stated that "new research and better technology have shown that while matéine has a chemical constituent similar to caffeine, the molecular binding is different. Matéine has none of the ill effects of caffeine."

There is ongoing debate within the scientific community and specialty tea industry in North and South America as to the exact nature of the stimulating alkaloids in yerba maté, their molecular structures, and the specific ways they affect the human body.

Aromatic Compounds

Compounds responsible for the distinctive yerba maté aroma have been suggested to be related to chemical transformations that occur during industrial manufacture (Bertoni, *et al.,* 1992).

Table 1. Principal Aromatic Compounds (Aliphatic, Terpenoids, Ketones, Acids and Aldehydes) found in Green and Toasted Yerba Maté, according to Kawakani and Kobayashi (1991).*

COMPOUND	GREEN MATÉ	ROASTED MATÉ
2-utoxyethanol	9.5	1.2
Linalool	7.5	0.9
Geranylacetone	3.4	1.8
Ocanoic acid	2.8	3.5
Hexanoic acid	2.8	3.2
1-pente-3-ol	2.5	0.9
Terpineol	1.9	0.4
Nonanoic acid	1.7	2.0
Geraniol	1.7	0.3
6-methyl-(E)-3,5-heptadien-2-one	1.6	1.0
6-methyl-5-hepten-2-one	1.5	1.3
2,6,6-trimethyl-2-hydroxcyclohexanone	1.5	1.1
-ionone	1.5	0.7
Octanol	1.4	1.5
5,6-epoxy-ß-ionone	1.4	1.3
ß-ionone	1.4	1.0
6,10,14-trimethylpentadecanone	1.3	1.7
Heptanol	1.3	1.5
(E)-2, (E)-4-heptadienal	1.3	1.0
Hexanal	1.2	0.4
(E)-2-pentenol	1.1	0.8
(E)-2-hexenal	1.1	0.5

* The numbers represent peak areas obtained from gas chromatograms of aroma concentrates.

Saponins

About 10 non-hemolytic, triterpene pentacyclic, either mono- or bidesmoside saponins have been recently isolated from *Ilex paraguayensis* (Gosmann, *et al.,* 1989, 1995; Kraemer, *et al.,* 1995b).

Such a high content of saponins (Schenkel *et al.,* 1996) also has an influence on the bitterness of yerba maté infusions.

The qualitative saponin composition of genuine yerba maté is quite different from that found in another South American *Ilex* species (Schenkel *et al.,* 1995b, 1996).

Phenolic Compounds

Phenolic compounds are relevant constituents of this species. Although Yerba maté does not contain true tannins (Rosovsky de Cernadas, 1983), among phenolic compounds, caffeoylquinic acid derivatives are important (Alikaridis, 1987; Clifford and Ramirez-Martinez, 1990). Among other similar substances, 3,5-dicaffeoylquinic acid, 3-caffeoylquinic acid and 5-caffeoylquinic acid are abundant, and may approach 10% (Brieger, 1995). *Ilex paraguayensis* has been suggested as an important source of chlorogenic acids (Clifford and Ramirez-Martinez, 1990).

Flavonoids

There is no doubt that yerba maté's leaves contain quercetin and quercetin 3-0-glycoside, i.e., rutin (Ricco *et al.,* 1995b). However, other data suggest that only kaempferol is present (Del Pero Martinez, *et al.,* 1996) or that a glycoside from the last aglycon accompanies quercetin and rutin (Ohem and Hölzl, 1988).

Anthocyanins are also components of the leaves and twigs (Ricco *et al.,* 1995a).

Minerals

In spite of the fact that most of the papers on the inorganic constituents of yerba maté are 30 or more years old, such papers are not scarce in the literature. However, various authors have reported only limited information about the conditions of their samples and different analytical methods. Thus, they frequently have also published different data about the composition of the ashes. Table 2 summarizes some of this information (Rosovsky de Cernadas, 1983).

<u>Table 2.</u> Relevant Inorganic Components from Yerba Maté

Mineral	K	Fe	Mg	Cu	Mn	Ca	P
%	1.1–1.35	0.05	0.33–0.39	0.001-0.14	0.14-1.3	0.66-0.68	0.069-0.12

Vitamins

Ascorbic acid (vitamin C) is relatively abundant in fresh yerba maté leaves, although more scarce as a component of twigs from the same tree. Vitamin C levels can suffer decreases of up to 58% of original levels during thermal industrial elaboration of the final yerba maté product (Rosovsky de Cernadas, 1983).

Since 1924, vitamin B_1 has been known to occur in *I. paraguayensis.* Vitamins B_2 and A are also present (Rosovsky de Cernadas, 1983).

PROPERTIES

The aqueous infusion of yerba maté has central nervous system stimulant properties because of its content of caffeine (between 2% to 3%, never less than 0.6%, a percentage that is enforced by law in Argentina).

Recent studies suggest that the total alkaloid content of a cup of yerba maté is quite similar to that of tea; however, the theobromine content of yerba maté is greater than that of tea (Clifford and Ramirez-Martinez, 1990). Methylxanthines are known to stimulate the myocardium, relax smooth muscles and induce diuresis (Salinas, 1988).

Yerba maté's antioxidant activity is related to its phenolic content. Its nutritional qualities are due to its content of A, C and B-complex vitamins, as well as the existence of minerals (Mg, P, Ca, Mn and Fe).

ALTERNATIVE USES

Dietary supplements as well as cosmetic uses of yerba maté are known both traditionally and industrially (Martinez-Crovetto, 1980). Soft drinks made with yerba maté have been popular for many years, primarily in South America and to a much lesser extent in North America. Standardized, concentrated extracts prepared from the botanical are now available and are put forth by manufacturers for use in functional foods, beverages and skin care products.

HISTORICAL SKETCH

In spite of the fact that no archeological evidence has been found to demonstrate the use of this species in pre-Columbian times, it is assumed that the Guarani Indians taught the Spanish about the virtues of *Ilex paraguayensis.* Legend has it that yerba maté was a household remedy for the Guarani Indians, who used it to boost immunity, detoxify the blood, tone the nervous system, combat fatigue and stress, stimulate the mind, and reduce the effects of debilitating illnesses.

Around the middle of the sixteenth century, Spanish documents at Asunción (Paraguay) started to mention the "yerba" (Grondona, 1953). However, the fact is that the first people to cultivate yerba maté were the Jesuit missionaries who, around 1670, already had yerba maté plantations (Porto, 1943). The economic importance of the yerba maté trade within the Spanish-American empire was recognized during the seventeenth and eighteenth centuries.

The expulsion of the Jesuits from the Spanish dominions (1767) was a step backwards in the crop history. Tree cultivation was replaced by forest exploitation, a situation that lasted until the end of the nineteenth century. The decline and complete disappearance of the yerba maté plantations in the settlements of Christianized Indians around 1820 meant that in the 1820s Brazil began commercial exploitation of its natural *ervais* (Giberti, 1994a). The immediate result was the appearance of the so-called "yerba de Paranaguá," by then considered to be of inferior quality to the product from Paraguay (Linhares, 1969). But in the long term, it replaced the Paraguayan yerba maté, in particular after the war of the Triple Alliance (1870).

At the end of the nineteenth century, the limitations of overexploitation of native yerba maté forests became very evident. This stimulated new research on yerba maté plantations. These eventually were successful in Argentina, a situation that led to that nation's position as the world's leading producer of yerba maté.

About the Author

Jorge Weil, M.D. is a physician, specializing in formulating herbal products and herbal remedies, as well as dietary supplements, with many years of experience in the international botanical industry. Former advisor to the Argentinean government regarding Yerba maté, Dr. Weil was physician to the Argentinean Olympic Committee (1987-91).

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