

Mate – a “new” caffeine-containing ingredient for the food and beverage industry

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Summary

Mate has gained increasing popularity. The concentrates and extracts are claimed to be innovative substances with various, mostly unsubstantiated health claims. Mate tea contains approximately 0.5 g/L caffeine, which is more than the amount in other caffeinated beverages (cola 0.1 g/L, tea 0.2 g/L, coffee 0.3 g/L). Mate may be added to tea mixtures and soft drinks, including energy drinks.

Keywords: mate, caffeine content, health effects, health claims, energy drinks

Introduction

The leaves of the mate tree (*Ilex paraguariensis*) were already used as a recreational drug and medicine by the original inhabitants of South America. In the 17th century, Jesuit missionaries started to cultivate mate plants in plantations and spread the mate tree throughout South America. At the end of the 18th century, mate was introduced to Europe as a medicinal plant. Mate tea is now a widely used and popular caffeinated beverage in South America and the Middle East. It is drunk for its taste and stimulant ef-

fects and is now also added to beers, soft drinks, juices, sweets and ice [1–3]. Mate tea has recently become more popular in the USA and in Europe and is sold and advertised as an innovative ingredient for beverages and food supplements [1].

Product research studies were performed during previous work on the caffeine intake of children and adolescents and these have shown that mate is present in many different beverages [4–8].

The present article describes the current knowledge of mate products and lists the foods and beverages that contain mate.

Methods

A literature search from 2000 for English language review articles was performed in the scientific databases PubMed and Food Science and Technology Abstracts (FSTA), using the keyword *Ilex paraguariensis*. Eleven articles were identified in PubMed and nine in FSTA and three of these

were used [1, 9, 10]. Two additional articles [2, 3] were identified through Google Scholar or elsewhere.

A market control was performed from 30 December 2013 to 4 January 2014 within the metropolitan area of Stuttgart, Germany. This covered different types of food retailers: 4 consumer or wholesale supermarkets, 3 discount stores, 4 organic grocery stores and 3 health food shops. This was complemented by parallel internet searches. The search was continued until no additional products were found after reasonable effort.

Current knowledge about mate

Botany and production

The mate tree or bush (*Ilex paraguariensis*) is a member of the holly (or ilex) family (*Aquifoliaceae*). In the wild, it grows up to 15 m in height. It requires a humid, subtropical climate (20–23 °C and intermediate to high air humidity) and grows at a mean elevation of 400–800 m.

The tea is produced from the leaves, which are light green, ovate, slightly dentate and leathery. They are up to 20 cm long and 8 cm broad (♦ Figure 1). The harvest takes place during the South American winter – both manually from wild growing trees and mechanically from plantation bushes. Both leaves and whole branches are harvested. These are then processed [9].

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Fig. 1: **Drawing of *Ilex paraguariensis*** [taken from Köhler's *Medizinal Pflanzen* [Medicinal Plants], Vol. 3 (1898). Verlag F.E. Köhler, Gera. Copyright expired, Scan used with permission from Missouri Botanical Garden (www.illustratedgarden.org)]

The total mate harvest in 2012 was 888,746 t in a cultivated area of 275,646 ha, of which more than 50 % was in Brazil, more than 30 % in Argentina and the remaining 20 % in Paraguay and Uruguay [11]. Most of the exported products are currently transported to the eastern Mediterranean, where hot caffeinated tea beverages are particularly popular [2].

Processing

After the harvest, the leaves must be treated. The commercial forms are green mate (mate taragin) and roasted mate (mate real). For both variants, crude mate is first produced. This is achieved by heating the leafy branch material in wire drums over fire for approximately 1 min at 400 °C. The water content is then reduced from 60 to 25 %. The material is next partially dried for 1–2 min at 80 °C in warm air, giving 15 % residual water content.

After cooling, the material is dried for a further 4 h at 80 °C under hot air, giving 8–9 % residual moisture. The leaves and stems are then crushed and pulverised and undesired portions of the stems are removed by sieving. The crude mate is then fermented. This may be conducted for several months at room temperature or for 30–45 days under warm air (50–60 °C).

After the fermentation, there is a final drying step to 2–3 % residual moisture. Green mate is then isolated by further pulverisation, sieving and mixing. For roasted mate, the raw mate is vigorously roasted at a higher temperature in the final drying process. This gives it a strong smoky taste. The mate can then be ground, mixed, roasted, packed or otherwise processed. Instant mate is prepared from raw mate by steam distillation.

The process steps and thus the final product vary greatly between different regions, producers and the desired final product [9, 12]. Mate generally has a comparatively high proportion of stem fragments. It may also contain fragments from other varieties of *Ilex* – either accidentally or to improve the taste. The heating process over fire appears to have a major effect on the smell and taste of the product [9]. As a result of the production process, mate may con-

tain a very high proportion of polycyclic aromatic hydrocarbons. However, only very small proportions of these contaminants are transferred to mate tea during the brewing process [13].

Mate and mate tea as an additive for food and beverages

To prepare mate tea, hot (but not boiling) water is added to about 1 teaspoonful of mate per cup. After 5–10 min, the mate is removed by sieving. The infusion can be repeated several times. As the caffeine is more rapidly dissolved than the tannins, the tea is more stimulating and the taste less strong after short infusion times. However, the taste is always bitter, tart and smoky. Mate tea contains approximately 78 mg caffeine per 150 mL cup [9], corresponding to approximately 0.5 g/L. This is clearly higher than the average content of other caffeinated beverages (cola 0.1 g/L, tea 0.2 g/L, coffee 0.3 g/L) [6].

♦ Table 1 lists our own current results on the caffeine content of mate tea and soft drinks containing mate.

Around the traditional cultivation areas, mate possesses cult character. It is still sometimes prepared and drunk in the traditional manner in

Sample	Caffeine content (n = 1)
Mate tea, without further information*	0.5 g/100 g tea powder
Mate tea with guarana, origin not given	1.6 g/100 g tea powder
Mate tea, roasted, origin not given	0.6 g/100 g tea powder
Mate tea, green (Argentina)	1.4 g/100 g tea powder
Soft drink with added mate, origin not given	190 mg/L beverage
Soft drink with added mate, origin not given	228 mg/L beverage

Tab. 1: **Caffeine content in 6 randomly selected mate products (determined by HPLC in accordance with DIN ISO 10727)**

* Theobromine: 51 mg/100 g (theobromine was not determined in the other samples)

Product group	Number of products	Data or claim for caffeine content	Comments	Anmerkungen
mate tea, pure (loose or in tea bag)	6	no information: 6	supermarket health food shop internet	green or roasted
mixture of herbal or fruit teas with mate (loose or in tea bag)	14	no information: 13 Imprecise information: 1*	supermarket health food shop internet	some product names refer to (putative) effect
alcohol-free soft drinks and energy drinks	23	no information: 4 0–19 mg/100 mL: 1 20–31 mg/100 mL: 13 32 mg/100 mL: 5	internet supermarket organic grocery store	including one drinking powder
alcoholic beverages	2	no information: 2	internet	
sports food	1	no information: 1	internet	carbohydrate gel

Tab. 2: Foods and beverages with mate which are available in food retail sale and through the internet (market check in the Stuttgart metropolitan area in January 2014)

* "2 cups of tea contain as much coffee as one cup of coffee"

the community, from special drinking vessels with a metal straw. For details, see e.g. [3].

For the preparation of foods and (particularly) beverages, not only green or roasted tea leaves and powders are used, but also liquids or concentrates or extracts dried to powders. These are used for teas, soft drinks, juices and sweets.

Bioactive ingredients and health effects

Mate leaves contain a number of secondary plant metabolites, including xanthines (1–2 % caffeine in dried leaves), theobromine, theophylline, saponins, minerals and vitamins [1, 9].

The content and transfer to the infusion depends on the type, processing after harvest, degree of grinding, mixing and type of preparation. The caffeine in mate is in the bound form, so that it is more slowly metabolised than the caffeine in coffee and its stimulating effect therefore lasts longer [9].

Mate is claimed to have several fa-

vourable effects on health. These have been subject to intensive research [1, 9] and are already used in the marketing for fitness and health purposes. This includes effects on fat metabolism and weight regulation, as well as anti-oxidative, anti-inflammatory, immune regulatory, anti-mutagenic and anti-carcinogenic effects. However, with the exception of caffeine's pharmacological activity [14], most of the effects of mate have only been studied *in vitro*. Thus, the available scientific evidence is not appropriate to justify stating health claims on labels or in food advertising. For example, in the context of health claims approval, the European Food Safety Authority (EFSA) has refused to accept industry claims that mate has diuretic or antioxidant cell-protective activity [15, 16]. Claims have also been rejected that there is a connection between caffeine and weight loss [17]. On the other hand, there is a proved correlation between caffeine intake of more than 75 mg/portion and increased alertness and attention [17]. Aside from the positive effects of mate, it has been suggested that it

may increase the risk of cancer of the oral cavity and oesophagus. It remains uncertain whether this is due to the fact that the tea is normally very hot, or that it contains harmful polycyclic aromatic hydrocarbons – which are formed in relatively high levels during heating over fire [10].

Mate is rarely used as a medicine. Because of caffeine's diuretic activity, mate is occasionally contained in tea mixtures recommended for mild infections of the urinary tract [18, 19], although – as mentioned above – there is no adequate scientific evidence for this.

Market check: foods and beverages with mate

♦ Table 2 lists the foods and drinks containing mate that are currently available.

The market check shows that the available products are focused on two areas. Firstly, mate is often added to tea mixtures. These are not intended to achieve stimulant effects, but for the putative benefits in health main-

tenance or weight loss. The second focus is on alcohol-free soft drinks and energy drinks. These usually emphasise the stimulatory effect. Some of the packaging and appearance is clearly intended for adolescents and young users. The products are regarded as “cool” in some scenes, as can be seen, for example, in some mate blogs.

Conclusion

The market check shows that mate tea and mate as beverage additive are now available on the German market. On the one hand, added benefit is claimed in the lifestyle area, e.g. for putative weight loss, even though there is no adequate evidence for this. On the other hand, mate is marketed as an alternative and trendy source of caffeine for young consumers.

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Conflict of Interest

The authors declare no conflict of interest according to the guidelines of the International Committee of Medical Journal Editors.

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