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COMPARATIVE QUANTITATIVE ANALYSIS OF SOME CLASSES OF BIOACTIVE COMPOUNDS IN SOME TEA SORTIMENTS AND TEALIKE INFUSIONS AVAILABLE ON THE ROMANIAN MARKET

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ABSTRACT

Two white tea types, Pai Mu Tan and Fujian blend and three popular non-tea infusions, yerba mate, rooibos and hibiscus tea were studied for determining the concentrations of chlorophyll, carotenoid, total phenolic and polyphenolic compounds and essential oil contents in raw plant material and pH of the resulting infusions.
White teas had the highest average amount of chlorophylls (746 mg/kg Fujian, 1,164 mg/kg Pai Mu Tan), the same being valid for carotenoids (218-226 mg/kg). Among non-tea beverages, rooibos had the highest amounts of both chlorophylls and carotenoids.
Total phenolic compounds also had the highest concentrations in white teas (43,617 mg/kg Pai Mu Tan, 47,522 mg/kg Fujian) followed by yerba mate (29,146 mg/kg). Total essential oils were much more variable, even among white teas (1,200-10,800 mg/kg), with high amounts in yerba mate and hibiscus tea.
pH values were similar, mildly acidic, except for the highly acidic (1.31) hibiscus tea.

INTRODUCTION

Billions of people worldwide drink tea as an energizing, revigorating and health-promoting drink. Tea is the most popular hot drink, more than 5 million tonnes being produced and consumed every year (FAO, 2015). In some parts of the world cold drinks, foods and deserts are also produced using tea.

Proper tea is produced using dried leaves of *Camellia sinensis* (L.) Kuntze (Fam. Theaceae), a shrub native to East Asia. There are many types of teas, according to the degree of fermentation (oxidation) of leaf tissue. These types also differ in their theine (caffeine) content. Caffeine is a stimulant of the central nervous system, and caffeine content gives tea its energizing properties. However, it makes tea consumption unsuitable at late hours, in large amounts (it may lead to nervousness, insomnia, headache) while intolerance to this compound can occur in some people.

White tea is one of the low-caffeine alternatives for tea drinkers. Produced from the buds or immature tea leaves subjected to steam-drying immediately after harvesting, in order to stop fermentation, white tea is the least processed tea and, with around 15 mg/kg caffeine, the lightest tea (compared to 40 mg/kg on average in green tea). Originating in China, nowadays its production and consumption is growing worldwide (Pawar 2018).

In other parts of the world, several low-caffeine alternatives have developed over time.

Yerba mate is produced from the heat-dried leaves of the South American shrub *Ilex paraguariensis* A.St.-Hil. (Fam. Aquifoliaceae). Strongly infused, it is the national drink of Argentina, Uruguay, Paraguay, Brazil, while its consupmtion is growing worldwide.

Rooibos tea is produced from the leaves of South African red bush (*Aspalathus linearis* (Burm.f.) R.Dahlgren (Fam. Fabaceae). Used for centuries by native peoples as a medicinal drink, it quickly grew up as a caffeine-free alternative to tea.

Hibiscus tea, or karkadeh is produced from the calyx of *Hibiscus sabdariffa* L. (Fam. Malvaceae). It is a traditional drink in many North African countries and it is completely caffeine-free (Nogueira Silva Lima et al. 2022).

Teas and similar drinks are known for high contents of bioactive compounds.

Chlorophylls (a and b, in land plants) are the main photosynthetic pigments. They have anti-inflammatory activity, stimulate wound healing and limit the accumulation of calcium oxalate dihydrate (and, thus, kidney stones). They also limit the uptake of some known carcinogenic compounds from food. Chlorophylls are antioxidant compounds, helping prevent oxidative stress-associated diseases (cardiovascular diseases, cancer; Inanç 2011).

Carotenoids (including carotenes, lutein, lycopene, zeaxanthin) are accessory photosynthetic pigments. They are key to biosynthesising retinol and melanin, essential for human eye and skin health. They are also effective antioxidant and antiproliferative compounds (Eldahshan & Singab 2013).

Phenolic compounds are a wide group of chemicals, working as pigments, antimicrobial and antifungal agents in plants. Flavonoids, phenolic acids and tannins are included in this class (Kivrak & Kivrak 2014). For human consumers, they are the most important class of antioxidants, redicung agents, radical scavengers and lipid oxidation inhibitors (Zymonė et al. 2018).

Volatile or essential oils are mixtures of various polyphenols (monoterpenes, sesquiterpenes and flavonoids), hydrocarbons and hydrocarbon derivatives, alcohols, esters, aldehydes etc., with a volatile fraction over 90%. They are responsible the specific aroma of vegetable foods and beverages, while they also have antioxidant and antibacterial properties (Orphanides et al. 2011).

The objective of this paper was to assess and compare the content of the above-mentioned classes of compounds in some white tea, yerba mate, rooibos and hibiscus tea sortiments available to Romanian consumers.

MATERIAL AND METHODS

Five types of herbal infusion ingredients were acquired from local commerce, as packaged dry plant material.

Fujian white tea consisted of a blend of white teas produced in Fujian Province, the source of most traditional white teas.

Pai Mu Tan (or *Bai Mu Dan*, “White Peony”) is one of the main types of Chinese white tea varieties, produced from one bud and 1-2 leaves harvested from each branch. It is known for as stronger and more flavoured than other white tea types (Chen et al. 2020).

Yerba mate, rooibos and hibiscus tea were taken into study as non-tea infusions.

Chlorophylls and carotenoids were determined by extracting plant material in 80% acetone, filtration and reading spectrophotometric absorption (S106 WPA spectrophotometer) at 470, 647, 663 nm (Popoviciu et al. 2020). Concentrations were calculated according to Lichtenthaler & Buschmann 2001.

The total concentration of phenolic compounds was determined by extracting plant tissue in methanol and reaction with Folin-Ciocâlteu reagent (10%) and sodium bicarbonate (7.5%) for 30 minutes. Absorbance was read at 765 nm. Standard gallic acid concentrations were used for the calibration curve (Stanković 2011, Siddiqui et al. 2017, Popoviciu et al. 2020).

Essential oils were determined by gravimetry. Ground plant tissue was extracted in petroleum ether (25 g per 5 g tissue). Solvent was evaporated at 35°C and the remaining residue weighed (Orphanides et al. 2011).

pH of infusions was determined by brewing of 1.5 g plant material in 120 mL boiling water for 3 minutes (Shrestha et al. 2010). The pH values were determined by using a HI98103 pH tester (Hanna Instruments). Nine replicate determinations were performed for each sample and biochemical analysis.

RESULTS AND DISCUSSIONS

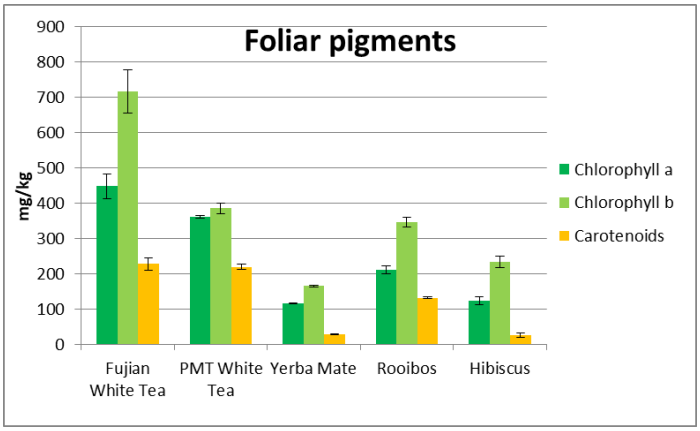

Figure 1. Concentrations of chlorophylls a and b and total carotenoids in selected infusion types (average values; mg/kg DW).

Among the five infusion types, white tea had significantly higher chlorophyll contents than non-tea beverages. Differences were also high between the two white tea types, with 1,164 mg/kg total chlorophylls in Fujian blend and 746 mg/kg in Pai Mu Tan, while only 280 mg/kg were found in yerba mate (Fig. 1). Values for white tea are similar to those found in green tea sortiments by Ošťádalová et al. (2014; 1,240-1,980) and Popoviciu et al (2020; up to 1,387 mg/kg).

Chlorophyll content is usually considered an indicator of tea quality. However it tends to undergo major decreases due to prolonged storage (after 2-5 months, depending on sortiment; Ošťádalová et al. 2014).

Carotenoids ranged between 25.42 (hibiscus, close to 27.24 in rooibos)-226.86 (Fujian white tea blend) mg/kg. While tea carotenoids are less studied, a research on 31 Chinese tea (fresh leaves) cultivars found 324.80-528.80 mg/kg total

carotenoids (Wei et al. 2016). Another research, on green teas in Romania found a wide variation, of 19.55-177.03 mg/kg (Popoviciu et al. 2020).

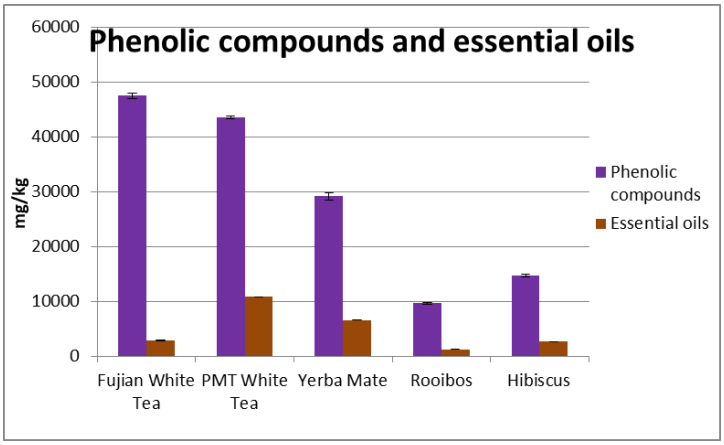

Figure 2. Concentrations of total phenolic and polyphenolic compounds and of essential oils in selected infusion types (average values; mg/kg).

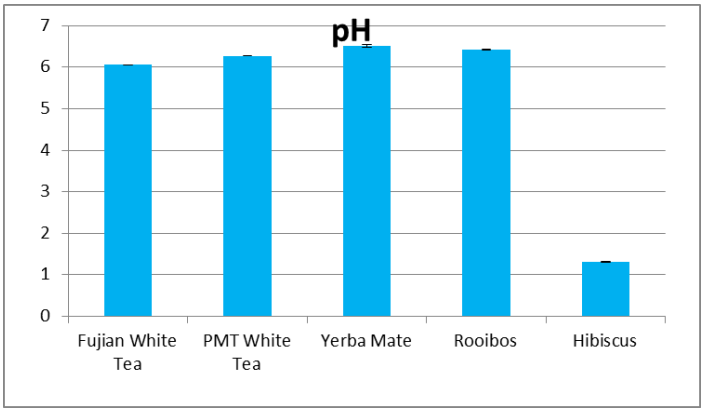

Figure 3. pH values for selected infusion types (average values).

Total phenolics varied between 9,616 (rooibos) and 47,522 (Fujian) mg/kg (Fig. 2). Differences were major between teas and non-tea infusions, with yerba mate having the highest values among the latter (29,146 mg/kg). For comparison, green teas can have anywhere between 19,000 -100,000 mg/kg and over (Lachman et al. 2003, Unachukwu et al. 2010, Popoviciu et al. 2020). This is the theoretical yield, since only a fraction can be effectively extracted during normal brewing (Lachman et al. 2003).

Volatile oils concentrations varied between 1,200 (rooibos) and 10,800 mg/kg (Pai Mu Tan). The two white teas showed major differences and yerba mate and even hibiscus tea had comparable values (Fig. 2).

pH values were mostly similar, mildly acidic for most infusions (6.06 Fujian-6.51 yerba mate; Fig. 3) with higher values in the non-tea drinks. The noteworthy exception was hibiscus tea, highly acidic, with only 1.31. Tea acidity is relevant,

among other reasons, because long term consumption of acidic drinks can lead to gastrointestinal disorders and the corrosion of dental enamel. While any drink with a pH lower than 7 can aggravate heartburn symptoms in some people, the critical value for enamel demineralization is 5.5 (Akyuz & Yarat 2010, Rao & Fuller 2018). All analyzed drinks except hibiscus tea surpass this value.

CONCLUSIONS

Among the five infusions, white teas had the highest average amount of chlorophylls (746 mg/kg Fujian, 1,164 mg/kg Pai Mu Tan), the same being valid for carotenoids (218-226 mg/kg). Among non-tea beverages, rooibos had the highest amounts of both chlorophylls and carotenoids.

Total phenolic compounds also had the highest concentrations in white teas (43,617 mg/kg Pai Mu Tan, 47,522 mg/kg Fujian) followed by yerba mate (29,146 mg/kg). Total essential oils were much more variable, even among white teas (1,200-10,800 mg/kg), with high amounts in yerba mate and hibiscus tea.

pH values were similar, mildly acidic, except for the highly acidic (1.31) hibiscus tea.

In conclusion, while non-tea drinks can be an alternative for consumers searching a totally caffeine-free alternative, the concentration on valuable compounds in white tea is significantly higher than in any non-tea infusion.

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