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ANTIOXIDANT PROPERTIES OF TEA AND HERBAL INFUSIONS – A SHORT REPORT

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Key words: tea, herbal infusions, antioxidants, polyphenols, $ABTS^{\bullet+}$, TEAC, GAE

The aim of the research was to determine the antioxidant properties of tea and herbal infusions and the content of total polyphenols.

The research material were teas and herbal teas available in retail trade, *i.e.*: *Camellia sinensis* teas such as green, black, Pu-erh and white tea as well as herbal teas from lemon balm leaves (*Folium Melissae*), peppermint leaves (*Folium Menthae Piperitae*) and chamomile (*Anthodium Chamomillae*).

The antioxidant activity was determined with a spectrophotometric method using synthetic cationradicals $ABTS^{\bullet+}$ and expressed as TEAC (Trolox Equivalent Antioxidant Capacity). The total polyphenol content was measured by using a Folin-Ciocalteu assay, and the results obtained were expressed as GAE (Gallic Acid Equivalent).

It was observed that the antioxidant proprieties of the herbal teas examined were considerably lower in comparison with those of the *Camellia sinensis* teas with a similar content of total polyphenols. A positive linear correlation was found between polyphenols content and antioxidant properties of individual teas and herbal teas.

Among the examined teas and herbal teas, green tea, white tea and black tea were characterised by the highest, whereas chamomile, peppermint and Pu-erh tea – by the lowest antioxidant activity.

INTRODUCTION

Epidemiologic studies have shown close links between the consumption of food rich in antioxidants and the incidence of various diseases [Dhalla *et al.*, 2000; Harrison *et al.*, 1999; Pitchumoni & Doraiswamy, 1998]. That is why special attention is paid to various raw materials, mainly of plant origin, which are their sources. Out of a number of substances known of their antioxidant activity special attention is paid to polyphenols occurring in various kinds of tea and herbal infusions [Majchrzak *et al.*, 2004; Das *et al*., 1997]. Their infusions are very popular drinks all over the world. They are a source of many polyphenolic compounds, such as flavonoids and phenolic acids [Kohlmünzer, 2003], and their content in the raw material affects the level of their antioxidant activity [Cai *et al.*, 2004]. The content of these compounds may differ not only due to the natural diversification of the raw material resulting from, *i.e.* different environmental growing conditions and various processing technologies (fermented teas, half-fermented, non-fermented), but also due to the method of their preparation (tea infusions, herbal infusions). As a consequence, a different level of their antioxidant activity should be expected.

In this study, the antioxidant properties and polyphenol content in infusions of various types of *Camellia sinensis* tea and herbal teas was compared in relation to their source of origin, *i.e.* producers.

MATERIALS AND METHODS

The experimental material were tea bags and herbal tea bags available in the retail trade, *i.e.*: green tea, black tea, Pu-erh tea, white tea as well as herbal teas from lemon balm leaves (*Folium Melissae*), peppermint leaves (*Folium Menthae Piperitae*) and chamomile (*Anthodium Chamomillae*). Determinations were conducted on the material from 3 different batches and at least in triplicate.

Infusions were prepared by adding 200 mL of deionised boiling water to 2 g of tea or herbal tea. The infusions were brewed under cover for 5 min (teas) or 10 min (herbal teas). The aqueous extract was obtained by filtering the mixture through filter paper and then used for analysis.

The antioxidant properties of the infusions examined were analysed with a spectrophotometric method with the use of $ABTS^{\bullet+}$ synthetic cationradicals. The results were presented as TEAC (Trolox Equivalent Antioxidant Capacity), *i.e.* as μmol of Trolox per 1 g of dry tea or herbal tea. The calculations were carried out for the solutions showing the ability to "scavenge" $ABTS^{\bullet+}$ cationradicals within the range of 20-80% based on curve calibration equation [Re *et al*., 1999]. Total polyphenols content was determined with Singleton & Rossi method [1965], and the results were presented as GAE (Gallic Acid Equivalent), *i.e.* mg of gallic acid per 1 g of dry tea or herbal tea.

Statistical analysis of the results was conducted with the use of Statgraphic 5.1. software for Windows. The results

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were subjected to the analysis of variance and LSD Fisher test at a significance level of $p \leq 0.05$.

RESULT AND DISCUSSION

The antioxidant proprieties of the examined infusions varied both depending on their kind and the producer (Table 1). The antioxidant proprieties of green, white and black tea were several times higher than those of herbal teas and red tea and ranged on average from 1328 to 1772 μmol of Trolox/g for teas and from 180 to 610 μmol of Trolox/g for herbal teas (Table 1).

The antioxidant proprieties of the examined herbal teas were considerably lower in comparison to *Camellia sinensis* teas and with the similar level of total polyphenol content (Table 1). It proves the higher antioxidant activity of polyphenols from *Camellia sinensis* teas.

The highest polyphenol content was found in lemon balm (158-236 mg of gallic acid/g), in green tea (120-185 mg of gallic acid/g), white tea (99-174 mg of gallic acid/g), black tea (112-151 mg of gallic acid/g) and peppermint (90-201 mg of gallic acid/g), whereas the lowest in Pu-erh tea and chamomile tea (42-69 and 36-54 mg of gallic acid/g, respectively) – Table 1.

TABLE 1. Antioxidant properties and total polyphenols content in the examined infusions of teas and herbal teas from different producers (1-21).

Infusion of	Producer	TEAC (μmol of Trolox / g)	GAE (mg of gallic acid / g)
Green tea	1	1723±92.8	146±3.2
	2	1418±27.4	120±1.7
	3	2191±136.4	185±5.8
	average	1772^{a}±320.9	150^{b}±27.7
Black tea	4	1551±53.1	121±2.7
	5	1149±47.8	112±2.5
	6	1703±68.7	151±4.3
	average	1328^{b}±209.1	130^{c}±18.2
Pu-erh tea	7	633±27.8	69±3.0
	8	406*±13.3	42****±1.5
	9	398*±7.7	41****±1.1
	average	494^{d}±116.3	51^{d}±13.5
White tea	10	1706±53.9	146±2.5
	11	2091±98.0	174±2.7
	12	1273±15.4	99±2.9
	average	1742^{a}±331.5	140^{bc}±32.0
Lemon balm	13	661**±29.9	232±1.0
	14	671**±19.0	236±0.4
	15	499±9.2	158±0.5
	average	610^{c}±83.0	209^{a}±36.9
Peppermint	16	597±30.4	201±0.3
	17	300±10.1	90±0.3
	18	356±22.9	97±0.5
	average	409^{d}±125.3	129^{c}±52.3
Chamomile	19	192±7.3	54±0.3
	20	173***±6.2	41±0.3
	21	174***±1.8	36±0.3
	average	180^{e}±10.2	44^{d}±7.9

* denotes a lack of significant differences between compared producers (ANOVA. $p>0.05$); the same letters in columns denote a lack of significant differences between compared means (ANOVA. $p>0.05$).

In the present study, it was shown that the total polyphenol content in the examined teas and herbal teas was positively correlated with their antioxidant properties (Figure 1).

Available literature lacks uniform methodology of presenting research results concerning both antioxidant properties and total polyphenol content. Authors use various methods of extraction (temperature, time, solvent) while preparing solutions for research and express final results considering different calculations [Zujko *et al.*, 2005; Singleton & Rossi, 1965; Cosio *et al.*, 2006; Ivanova *et al.*, 2005; Mantle *et al.*, 2000], which makes it difficult to compare results obtained in the present research with the results obtained by other authors. In spite of this, great consistency was observed between the results obtained and previously published data.

Zujko *et al.* [2005] determined total polyphenol content in various herbal infusions and simultaneously studied their antioxidant activity. They showed that the highest antioxidant activity of lemon balm was connected with the highest content of total polyphenols (482 mg GAE/L), expressed as gallic acid (GAE). Infusions prepared from chamomile had the lowest content of polyphenols (mean 105 mg GAE/L) and were also characterised with the lowest antioxidant activity. In the herbs studied, there was essential relation between polyphenols content and their antioxidant activity. The same relation was observed in the present study.

Ivanova *et al.* [2005] examined the antioxidant activity (TEAC) of teas and herbal tea infusions and determined a higher activity in green and black tea as compared to peppermint (4.7 and 3.1 times more, respectively).

In Almajano *et al.* [2008] research, a high antioxidant activity and polyphenols content were determined in infu-

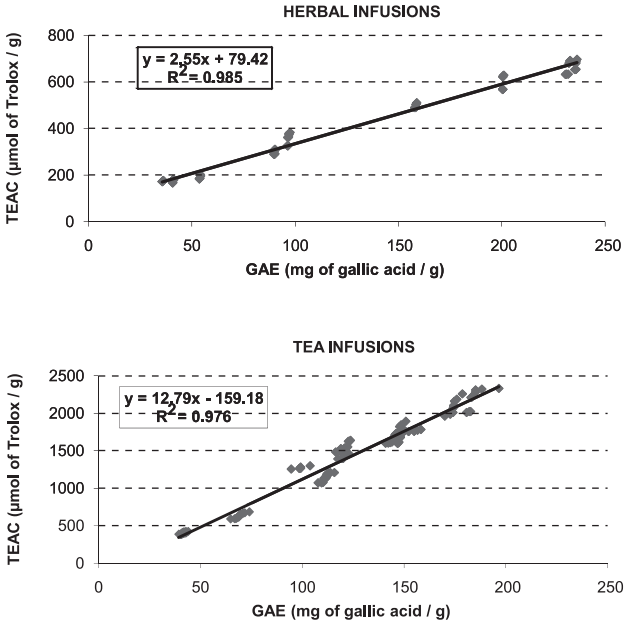

FIGURE 1. Correlations between the total polyphenols content in infusions and their antioxidant proprieties.

sions of green tea (6344 mmol TE/L and 2083 mg GAE/L), white tea (4546 mmol TE/L and 2180 mg GAE/L) and black tea (3771 mmol TE/L and 1844 mg GAE/L), whereas lower ones in Pu-erh teas (1215 mmol TE/L and 825 mg GAE/L). The lowest content of polyphenols was shown in peppermint infusion. Similar relations were obtained in the present study.

Alarcón *et al*. [2008] showed that infusions from chamomile were characterised by much lower polyphenol content and antioxidant activity (ORAC method) than infusions from green, white and black teas. In Aoshima *et al.* [2007] study, it was shown that the antioxidant activity of green tea infusions was higher than that in peppermint and chamomile infusions, which accounted for respectively 73.1%, 30.3% and 6.7% of DPPH radicals "scavengings". The infusions of green tea were also characterised by a higher content of polyphenols. These authors showed also a close relationship (a correlation factor of 0.950) between total polyphenol concentration in teas and antioxidant activity. These relations were observed in the present study.

Cai *et al*. [2004] studied 112 plant species used in Chinese medicine. They showed that plants with a higher content of total polyphenols had a higher antioxidant activity (expressed as TEAC).

The differences in the antioxidant activity presented in previous studies may be due to implementation of different analytical methods and methods for infusions preparation (infusion concentration, temperature, brewing time). The antioxidant properties of plants and polyphenol content depend on many factors, *i.e.* soil and climate conditions in which plant was cultivated, harvest seasons, methods of processing and storage [Capecka *et al.*, 2005], parts of plant which the infusion was made of [Carnat *et al.*, 1998; Ivanova *et al.*, 2005; Mantle *et al.*, 2000] and plant species [Ivanova *et al.*, 2005]. Hence, the antioxidant properties of plant can be different in water infusions. That indicates the necessity of controlling and monitoring these parameters for particular raw material.

CONCLUSIONS

1. The antioxidant properties of the herbal teas examined were considerably lower in comparison with those of the *Camellia sinensis* teas and both groups had the approximately the same level of total polyphenols. It proves that *Camellia sinensis* teas have a higher antioxidant activity of polyphenols.

2. Out of the teas and herbal teas examined – green tea, white tea and black tea were characterised by the highest antioxidant activity, whereas the lowest one was observed in chamomile, peppermint and Pu-erh tea.

3. Total polyphenols content in individual teas and herbal teas was positively correlated with the antioxidant activity expressed as TEAC.

4. Great variation was observed in the antioxidant activity of particular teas from different producers, which emphasizes the need to establish proper technological parameters in teas production as well as systematical control of their antioxidant properties.

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