Influence of Phenolic Compounds on Sensory Parameters of Tea Infusions

P. KOŠULIČ, J. POKORNÝ and Z. PANOVSKÁ*

*Department of Food Chemistry and Analysis, Institute of Chemical Technology, Prague, Czech Republic, *E-mail: kosulicp@vscht.cz*

Abstract: A set of 9 black teas and 10 green teas were analyzed. Sensory parameters of tea infusions were correlated with the content of total polyphenols (determined after Folin and Ciocalteu) and sensory parameters (determined after ISO standards). Total polyphenols affect both the astringency and the bitterness of green tea and black tea infusions. The relations are mainly semilogarithmic, but very close to linear. Sucrose decreased the astringency by 30–40%, and the bitterness was suppressed still more.

Keywords: astringency; bitterness; polyphenols; sensory analysis; sweetness; tea infusions

INTRODUCTION

Tea infusions belong to the most widely used beverages throughout the world. In the last century, tea attained high acceptance even in the Czech Republic. Tea bushes are grown in many countries of subtropical and tropical area, irrespective of the soil type, often in mountain areas. Not only the variety, but also both the climate, agrotechnology and soil composition affect the chemical composition and sensory characteristics of tea infusions. The total amount and composition of tea tannins, particularly catechins, is of primary importance [1]. The typical taste of tea infusions is due to the bitter taste of caffeine and to the astringent taste of catechins as the major factors, but also on the aroma and technological conditions of preparation of tea infusion. During the fermentation in the preparation of black tea, tannins present in green tea are partially converted in tea pigments – theaflavins and thearubigins. In earlier experiments carried out in this laboratory on black tea infusions, we studied the relation of the content of tea tannins and the intensity of astringent taste [2] and the relation between the caffeine content and the bitterness intensity [3]. Both relations were found statistically significant. As green tea becomes consumed more frequently in the Czech Republic and in other EU countries now, we studied the relation between the content of total polyphenolic substances and the intensity of astringent and bitter tastes of both green and black tea infusions.

EXPERIMENTAL

Materials and methods. Samples of nine black teas and ten green teas were analyzed (Table 1). Tea infusions were prepared in the following way: Tea leaves were weighed into two 1000 ml beakers, 5.0 and 7.5 g, respectively. Tap water was heated to the starting boiling, and at 95°C 500 ml were poured into each beaker. The suspension was left for 2 min, stirred, and left again for 2 min. The suspension was then filtered through a stainless steel sieve. Samples for sensory tests were thus prepared either from 1.5 g or 1.0 g leaves per 100 ml. Sweetened infusions contained 5 g sucrose per 100 ml.

The content of polyphenolic substances in tea infusions was determined spectrophotometrically after Folin-Ciocalteu [4], only that the dilution was adapted to the analyzed samples, and the absorbance was measured at 765 nm, in agreement with recent findings (the difference is only moderate). The result is expressed as mg of gallic acid per 1 l of infusion.

Table 1. List of tea samples used in the experiments

Green teas	Country	Black teas	Country
Gu Zhang Mao Jian	China	Yunnan FOP	China
Gunpowder	China	Keemun Congou	China
Lung Ching	China	Assam GFOP	India
Moon palace	China	Sikkim FTGFOP	India
Green Dragon	China	Darjeeling Leaf Tea	India
Kokeicha	Japan	Ceylon OPA Tea	Ceylon
Sencha	Japan	Ceylon OPI Pettiagalia	Ceylon
Bancha Houjicha	Japan	Nepal FTGFOP Maloom	Nepal
Tan Cuong	Vietnam	Kenya GFBOP	Kenya
Darjeeling Dagapur	India		

The sensory analysis was carried out in a test room equipped with six test booths after the international standard [5], and the presentation of samples was also in agreement with the respective international standard [6]. The assessors' panel consisted of persons selected, trained and monitored after the respective international standard [7]. Four 100 ml samples were presented to each assessor at a session in the random order. Tap water was used as a neutralizing agent. The assessors determined the intensity of overall acceptance, the intensities of sweet, astringent and bitter tastes. Unstructured graphical scales, represented by straight lines 100 mm long, oriented by verbal description on the two ends, were used for grading both intensities and acceptancies. As the astringent and bitter intensity ratings were located in the interval of 10–90% of the scale, the scale was regarded as an interval scale after McBride [8], and logarithms, means and standard deviations were calculated.

RESULTS AND DISCUSSION

The polyphenol content in tea infusions is summarized in Table 2. The values obtained in the subset of green tea infusions were substantially higher than in case of black tea infusions as could be expected because of partial decomposition of tea leaf polyphenols during the fermentation [9]. The astringencies of both unsweetened and sweetened tea infusions are shown in Table 3 and linear regressions are compared with semilogarithmic regressions in Figures 1(a) and 1(b). The values of infusions prepared from green tea were higher than those prepared from black tea, as expected because of higher polyphenol content in green teas. The astringency intensity of green and black tea infusions varied between 24–48% and 13–33% in sets of unsweetened and sweetened infusions, respectively. Addition of sugar thus suppressed the astringency. Tea Bancha Houjicha behaved differently from other tea samples because of its exceptional composition. Two other Chinese tea samples – Keemun and Yunnan – showed lower polyphenol contents and lower astringencies than other green teas. On the contrary, tea Kenya showed higher polyphenol content and higher astringency than other samples.

Relations between the polyphenol content and the astringency are shown in Table 4. In all cases, the linear and semilogarithmic regressions gave similar agreement with experimental data. The regressions were similar for green and black teas, therefore, only the values for the total set of tea samples are shown in the Table 4. The astringency depends mostly on tea tannins [10], even when other phenolic substances could contribute, too. Some polyphenols produce bitter sensations, too [11]. Therefore, the respective regressions for bitterness are included, too. The respective R^2 values are slightly lower than in case of astringency, but the expressions are still statistically significant. Both astringency and bitterness intensities are related in sweetened and also in unsweetened tea infusions, and intensities of astringency are related to the intensities of bitterness. It is interesting that these two sensory parameters are so closely related even when the bitterness belongs to basic tastes and the astringency to trigeminal senses. The effect of polyphenolic substances on both the astringency and bitterness evidently contributes

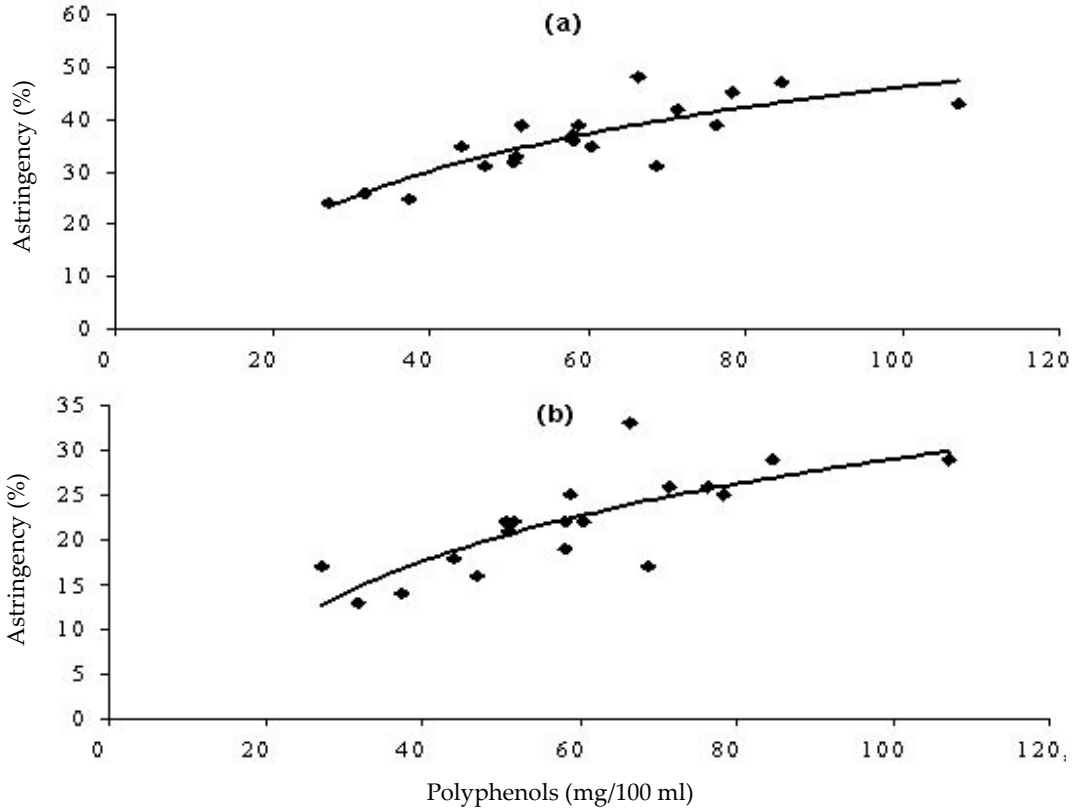

Figure 1. Dependence of astringency of unsweetened (a) and sweetened (b) infusion and polyphenolic content

Table 2. Content of polyphenolic substances in tea infusion

Tea sample	Polyphenols (mg/100 ml)	Standard deviation
Gu Zhang Mao Jian	76.2	14.3
Gunpowder	44.1	5.1
Lung Ching	71.4	2.0
Moon palace	84.6	1.6
Green Dragon	107.2	5.8
Kokeicha	78.5	2.1
Sencha	60.5	5.4
Bancha Houjicha	31.7	2.2
Tan Cuong	68.6	3.6
Darjeeling Dagapur	58.3	0.2
Yunnan FOP	37.4	0.1
Keemun Congou	27.0	0.6
Assam GFOP	50.8	0.3
Sikkim FTGFOP	50.6	0.1
Darjeeling Leaf Tea	58.3	0.2
Ceylon OPA Tea	47.0	0.4
Ceylon OPI Pettiagalia	51.5	0.9
Nepal FTGFOP Maloom	58.7	0.4
Kenya GFBOP	66.4	0.3

Table 3. Astringency of tea infusions

Tea sample	Unsweetened sample (%)	Sweetened sample (%)	Astringency decrease (relative %)
Gu Zhang Mao Jian	39	26	33.3
Gunpowder	35	18	48.6
Lung Ching	42	26	38.1
Moon palace	47	29	38.3
Green Dragon	43	29	32.6
Kokeicha	45	25	44.4
Sencha	35	22	37.1
Bancha Houjicha	26	13	50.0
Tan Cuong	31	17	45.2
Darjeeling Dagapur	37	22	40.5
Yunnan FOP	25	14	44.0
Keemun Congou	24	17	29.2
Assam GFOP	33	21	36.4
Sikkim FTGFOP	32	22	31.3
Darjeeling Leaf Tea	36	19	47.2
Ceylon OPA Tea	31	16	48.4
Ceylon OPI Pettiagalia	39	22	43.6
Nepal FTGFOP Maloom	39	25	35.9
Kenya GFBOP	48	33	31.3

Table 4. Relations between polyphenol content and sensory parameters

Linear regressions		Semilogarithmic regressions	
AU = 0.291 P + 18.9	r^2 = 0.633	AU = 17.4 ln P – 34.0	r^2 = 0.696
AS = 0.214 P + 9.2	r^2 = 0.590	AS = 12.4 ln P – 28.0	r^2 = 0.603
BU = 0.232 P + 19.2	r^2 = 0.555	BU = 12.9 ln P – 18.9	r^2 = 0.525
BS = 0.145 P + 6.26	r^2 = 0.362	BS = 8.9 ln P – 21.1	r^2 = 0.421
AS = 0.700 AU – 3.4	r^2 = 0.839	AS = 23.9 ln AU – 63.3	r^2 = 0.809
BS = 0.593 BU – 4.623	r^2 = 0.582	BS = 19.548 ln BU – 53.1	r^2 = 0.579
AS = 0.718 BS + 11.2	r^2 = 0.386	AS = 23.9 ln BS – 63.3	r^2 = 0.386

A = astringency; B = bitterness; P = polyphenols; U = unsweetened; S = sweetened

to these relations and is more important than the effect of caffeine on the bitterness.

References

[1] Bokuchava M.A., Skobeleva N.I. (1969): Adv. Food Res., **17**: 215.

[2] Pokorný J., Lai G.K., Štouračová M., Davídek J. (1987): Sb. VŠCHT v Praze E, **61**: 195.

[3] Lai G.K., Pokorný J., Davídek J., Valentová H. (1987): Sb. VŠCHT v Praze E, **61**: 95.

[4] Singleton V.L., Orthofer R., Lamnek-Raventós R.M. (1999): Meth. Enzymol., **299 A**: 152.

[5] ISO 8589 (1988): Sensory analysis – General guidance for the design of test rooms. Int. Org. Standardization, Geneva.

[6] ISO 6658 (1985): Sensory analysis – General guidance. Int. Org. Standardization, Geneva.

[7] ISO 8586-1 (1991): Sensory analysis – General guidance for the selection, training and testing of qualified assessors. Int. Org. Standardization, Geneva.

[8] McBride R.L. (1985): Food Res. Quart., **45**: 59.

[9] Obanda M., Okinda Owuor P., Mang'oka R. (2001): Food Chem., **75**: 395.

[10] Kielhorn S., Thorngate J.H. III. (1999): Food Qual. Preference, **10**: 109.

[11] Rossi J.A. Jr., Singleton V.L. (1966): J. Enol. Viticult., **17**: 240.