The Selection of the Optimal Rate of Acid and Sweet Taste for Lemon Flavoured Drops

A. VÁCHOVÁ, Z. PANOVSKÁ and D. LUKEŠOVÁ*

*Department of Food Chemistry and Analysis, Institute of Chemical Technology in Prague, 166 28 Prague, Czech Republic, *E-mail: alena.vachova@vscht.cz*

Abstract: The objective of this work was to choose an optimal rate of citric acid and sweeteners for lemon flavoured drops. Two model samples with defined concentrations of citric acid and two commercial samples were evaluated with using instrumental and sensory methods. Concentrations of sweetening agents and citric acid in the samples were determined using HPLC with a RI detector and isotachophoresis, respectively. The general pleasantness of taste and the intensity of acid and sweet tastes of four lemon drops were evaluated using sensory analysis. General pleasantness was evaluated using a ranking test. Intensities of acid and sweet tastes were evaluated using unstructured graphic scales. The best tasting lemon drops contained 11 g/kg of citric acid and 691 g/kg sweeteners related to the sweet potency of sucrose. The sample with an extremely acid taste was considered unpleasant for most assessors (Friedman, $\alpha = 0.05$). Generally, the assessors preferred the lemon drops with well-balanced acid and sweet tastes.

Keywords: sweets; acid taste; sweet taste; sensory evaluation

INTRODUCTION

Tastes significantly influence the selection and pleasure of food. There are four properties that make individual taste sensation unique: the quality, intensity, temporal and spatial patterns. When assessing mixtures of taste, three levels of interactions must be taken into account: the chemical interaction, the interaction between one of the mixture compounds and the taste receptors, and the cognitive effect of different taste qualities being perceived together in the mouth (Keast & Breskin 2002). Lemon flavoured drops are hard candies containing mainly carbohydrates, starch syrup, citric or tartaric acid, lemon flavour and they are typically coloured yellow. The acid-sweet interactions are very important for the perceived taste of lemon drops. It is known that the medium and high intensities of sweetness generally suppress other basic tastes. The influences of medium and high intensities of sourness have no clear effect on sweet taste (Keast & Breskin 2002).

The objective of the work was to determine the optimal rate of citric acid and sweeteners for consumers which would be typical for lemon flavoured drops.

MATERIAL AND METHODS

Material. Two model samples were described as a sample A and sample B and were provided by a Czech confectionery producer (the producer did not want to be mentioned). The model samples were compared with the two commercial acid drops, namely acid drops Bonlimon (ŽITO ŠUMI, d.o.o., Ljubljana, Slovenia) and Zozole (Zaklady Prezmyslu Cukierniczego "Mieszko", Racibórz, Poland). The evaluated samples had the same kind of aroma, colour, with similar sizes and structures. The ability of assessors to recognise acid and sweet tastes was measured for citric acid monohydrate p.a. (Lach-Ner, s.r.o, Neratovice, Czech Republic) and sucrose p.a. (Lach-Ner, s.r.o., Neratovice, Czech Republic), respectively. Water solutions were prepared from tap water (Vyhláška č. 252/2004 Sb.).

Instrumental analysis. The contents of citric acid and sweeteners were determined using

capillary isotachophoresis and HPLC, respectively. The content of citric acid was measured on the instrument Villa Labeco ZKI 02 (Labeco, Czechoslovakia) with an UV absorbance detector. The sample (0.1 g) was diluted in a 50 ml flask with water and the sample solution was filtrated through the paper filter. The measurement conditions were the same as for the work of Kvasnička *et al.* (2002). Glucose, fructose and sucrose were quantified by the HPLC instrument with a high-pressure pump (LCP 3001; Laboratorní přístroje, Prague, Czech Republic) and an Ostion analytical column (OSTION LG KS 0800, Ca^{2+}, 250 × 8 mm). The sample (1 g) was diluted in a 50 ml flask with distilled water. The measurement was done under the following conditions: mobile phase of degassed distilled water at a flow rate 0.5 ml/min, temperature 80°C, pressure 8 MPa, and refractive index detector. Samples were analysed by filtering through a 0.45 μm filter, injecting 20 μl, and measuring peak heights. An external standard method was used for the determination of a particular sugar. The chromatograms were evaluated with a PC system using CSW software (DataApex, Prague, Czech Republic).

Sensory analysis. The sensory assessments were done by a panel of 70 volunteers (55 women and 15 men) aged 19 to 55 years old, recruited from students and staff of the Faculty of Food and Biochemical Technology, Institute of Chemical Technology in Prague. The abilities of assessors to detect and recognise the acid and sweet tastes in aqueous solutions were measured. The concentrations of the tested acid and sweetening agent were corresponding with ISO 3972 (1991) and were in the range of 0.13–0.60 g/l for citric acid and 0.34–12.00 g/l for sucrose. Tests were based on the Ascending Forced-Choice method (3-AFC). Two samples of water and one sample of the test solution were presented to each candidate. The assessors were required to choose the sample with the taste stimuli.

The lemon drops were tested using different sensory methods. Intensities of acid and sweet tastes were evaluated with using unstructured graphical scales represented by a straight line 100 mm long, oriented by a description at the two ends (0% = imperceptible, 100% = extremely strong). General pleasantness was evaluated using a ranking test. The samples were ranked from the most pleasant to the unpleasant. The ranking evaluation was performed according to Friedman procedure, $\alpha = 0.05$ (ISO 8587, 2006).

The sample was ingested and moved in the mouth for 2 minutes. The next sample was evaluated in one minute after rinsing the mouth with water.

RESULTS AND DISCUSSION

The concentrations of citric acid and sweeteners for each evaluated sample are shown in Table 1. The contents of glucose and fructose were recalculated in the relation to the sweet potency of sucrose. The concentration of citric acid in sample A was more than two times lower than in sample B and drops of Zozole.

The ability of the assessors to recognise the acid taste and the sweet taste was evaluated in aqueous solutions. More than 50% of the assessors were able to identify the acid taste of citric acid in the concentration of 0.17 g/l. The recognition threshold for sucrose was 1.71 g/l. The thresholds of analysed tastes were slightly lower for our assessors in comparison with the literature (Mojet *et al*. 2001).

Table 1. Concentrations of citric acid and sweetening agents in drops

	Concentration (g/kg)				
	citric acid	sucrose	glucose	fructose	∑ sugars after recalculacion[a]
Sample A	11	580	130	22	691
Sample B	25	555	123	13	648
Bonlimon	13	609	130	40	747
Zozole	24	632	126	17	733

[a]concentrations of glucose and fructose were recalculated in the relation to the sweet potency of sucrose; the content of glucose was multiplied by coefficient of 0.6, the content of fructose was multiplied by coefficient of 1.5 (Nabors & Gelardi 1991)

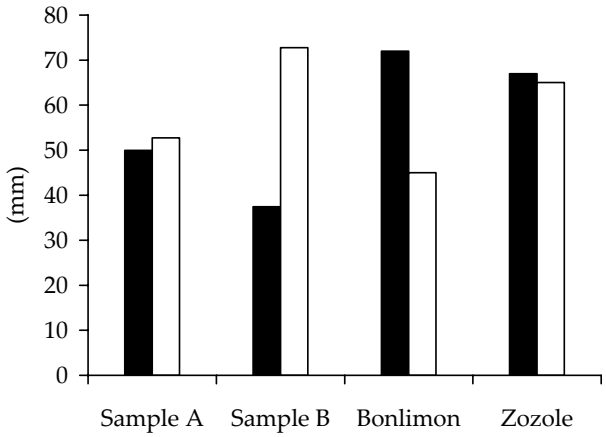

Figure 1. Perceived intensities of sweet (■) and acid (□) tastes of lemon drops samples

The average values of perceived intensities of acid and sweet tastes for lemon flavoured drops are described in Figure 1. Significant differences in the intensity of acid taste were found between samples A and B, the sample B and Bonlimon, and Bonlimon and Zozole (Kruskal-Wallis test, $\alpha = 0.05$). Significant differences at the intensity of sweet taste were found between the sample A and drops Bonlimon, the sample B and Bonlimon drops, and Bonlimon drops and Zozole drops.

General pleasantness was evaluated using the ranking test. As the best tasting sample was chosen the model sample A. It contained 11 g/kg of citric acid and 580 g/kg of sucrose, 130 g/kg of glucose and 22 g/kg of fructose (FR = 8.37, $\chi^2_{0,95} = 7.81$ for four samples). The sample A was also described as the sample with well-balanced acid and sweet tastes.

Differences were also found between samples A and Zozole as well as between sample B and Bonlimon drops. The sample B, the second model sample, had an extremely acid taste and was judged as unpleasant by most of assessors. It is very well known that high concentrations of acids evoke innate rejection responses in humans (Kim *et al.* 2004) but the stronger acid taste is typical for lemon flavoured drops. It is important to choose the right concentrations of acid and sweeteners that would be acceptable and pleasant for most consumers and they should correspond with the imagination typical of that kind of product.

Acknowledgement: This research was supported by the Ministry of Education, Youth and Sports of the Czech Republic, Project No. MSM 6046137305.

References

ISO 3972 (1991): Sensory analysis. Methodology. Method of investigating sensitivity of taste. International Organization for Standardization, Geneva.

ISO 8587 (2006): Sensory analysis. Methodology. Ranking. International Organization for Standardization, Geneva.

Keast R.S.J., Breskin P.A.S. (2002): An overview of binary taste-taste interactions. Food Quality and Preference, **14**: 111–124.

Kim U.K., Breslin P.A.S., Reed D., Drayna D. (2004): Genetics of human taste perception. Journal of Dental Research, **83**: 448–453.

Kvasnička F., Voldřich M., Pyš P., Vinš I. (2002): Determination of isocitric acid content in fruit juices – detection of authenticity. Journal of Food Composition and Analysis, **15**: 685–691.

Mojet J., Christ-Hazelhof E., Heidema J. (2001): Taste perception with age: generic or specific losses in threshold sensitivity to the five basic tastes. Chemical Senses, **26**: 845–860.

Nabors L., Gelardi R.C. (1991): Alternative Sweeteners. 2nd Ed. Marcel Dekker, Inc., New York.

Vyhláška č. 255/2004 Sb. z 22. 4. 2004, kterou se stanoví hygienické požadavky na pitnou a teplou vodu a četnost a rozsah kontroly pitné vody. Ministerstvo zdravotnictví ČR, Praha.