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Comparison of two sensory methods to obtain reliable dose-intensity curves for sweet taste compounds

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Introduction

This study aimed to compare two methods for delivering sweet solutions that were evaluated for sweetness intensity by a panel of 29 trained subjects: a Conventional Sensory Analysis (CSA) and a Gustometer-assisted Sensory Analysis (GSA) method. The advantage of the GSA method is to increase the frequency of delivery of the samples and thus to carry out a more extensive screening of the ranges of sweetening agents.

Materials and methods

Panel

Evaluations were performed by a panel of 29 judges selected and trained to rate sweetness intensity with an open-ended ratio scale [1]. This scale (Fig. 1) is a scale with sensory anchors. Sensory references (sugar solutions) are given to panelists for the different anchors. This scale has interval and ratio properties, the distances and ratios between the anchors refer to a taste reality [2].



Figure 1: Scale used for the assessment of sweetness intensity by the expert panel

Sweeteners

Three kinds of sweetener were tested: a bulk sweetener, Sucrose (Cas N°57-50-1); an intensive natural sweetener, Rebaudioside A (Cas N°58543-16-1); and an intensive artificial sweetener, Cyclamate de Sodium(Cas N° 135-05-9) at different concentrations (Table 1).

		Level 0.5	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
[Sucrose] g/L	CSA		20	40	60	85	125	250
	GSA	10	20	40	60	85	125	
[Reb A] g/L	CSA		0.002	0.065	0.12	0.19	0.3	0.52
	GSA	0.01	0.002	0.065	0.12	0.19	0.3	0.52
[Cyclamate de Na] g/L	CSA		0.1	0.25	0.6	1.5	4	5
	GSA		0.1	0.25	0.6	1.5	4	5

Table 1: Sweetners' concentrations used in each method

Sensory analysis methods

- Conventional Sensory analysis (CSA)

16 judges per session were seated in individual, semi-open booths with controlled light, temperature, and ventilation (Fig. 2). 10mL of sweetener samples were anonymized and tasted in random order. Maximum 44 samples were rated for each judge in 1 hour (figure 3).

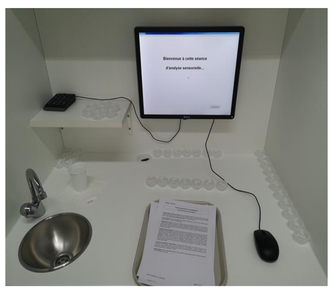


Figure 2: CSA booth

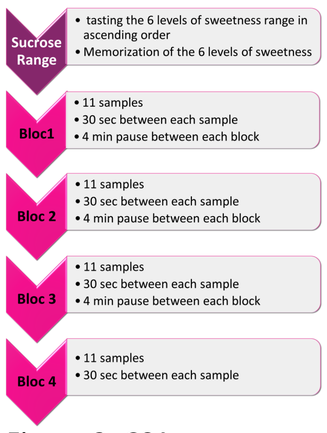


Figure 3: CSA sequence

- Gustometer-assisted sensory analysis (GSA)



Figure 4: Burghart gustometer

In a 1.5 hour individual session, 400µL of samples were delivered directly into the judge's mouth by a gustometer (Burghart Gmbh, Germany) (Fig. 4). The OG-Control software was used to control the gustometer and manage the random sequences of sample presentation. Samples were delivered during 500ms to the judge, then sweetness intensity was rated and the mouth was rinsed with 2.5mL water (Fig. 5). As in CSA, the session started with the sucrose range, then 3 blocs of 40 samples were rated (all the samples were evaluated in each block).

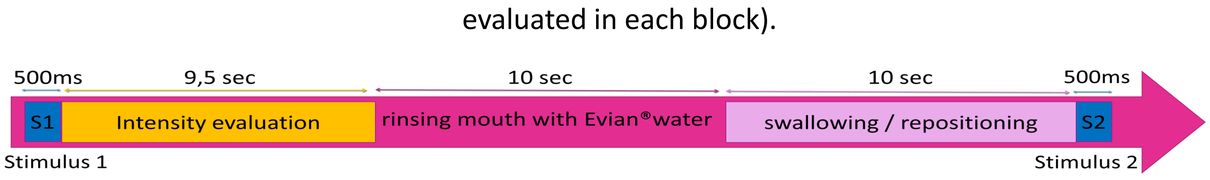


Figure 5: GSA stimulation procedure

Data analysis

Results were collected with the Fizz® software for the 3 selected sweeteners. For both methods, dose-response curves were fitted using the R Software with a Weibull model. Graphical representation of individual results according to the average model and EC50 calculation were performed using R.

Refrences: [1] Lawless, H. T., & Heymann, H. (2010). Sensory Evaluation of Food 5 (Chap 7, p149-174). Springer New York.

[2] Atanasova, B., Thomas-Danguin, T., Langlois, D., Nicklaus, S., & Etievant, P. (2004). Perceptual interactions between fruity and woody notes of wine. Flavour and Fragrance Journal, 19(6), 476-482.

Results

Dose-response curves

For each sensory method (CSA and GSA) and each sweetener, an average model is estimated to represent the dose-response curve at the panel level (Fig. 6). This model is represented as a dose-response curve of the sweetness intensity experienced by the judges as a function of compound concentration.

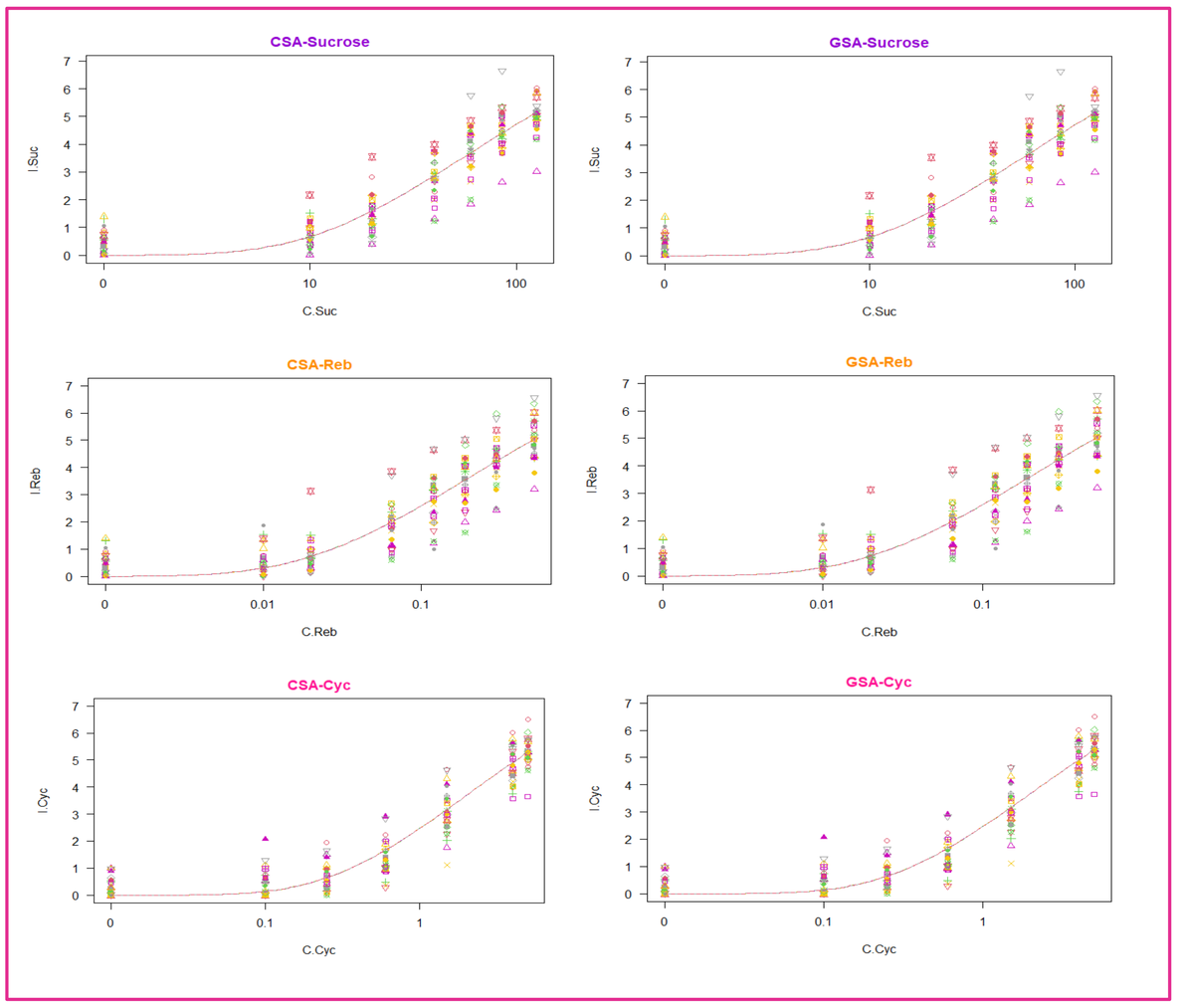


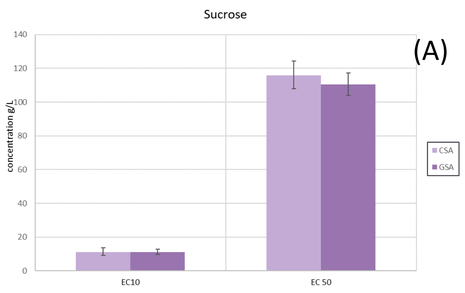
Figure 6: Dose-response curves

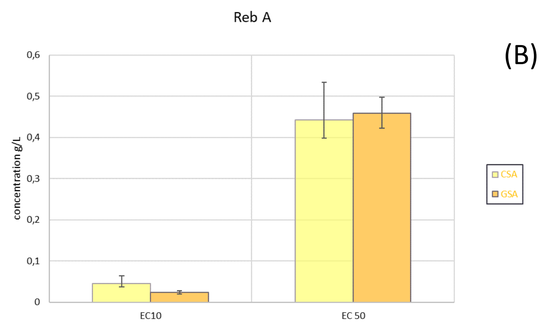
EC 10 and 50 calculation

The EC10 and EC50 are the concentrations that respectively give 10% and 50% of the maximum intensity. These values were determined statistically by modeling the curve (Table2). 95% Confidence Intervals were calculated and represented (Fig.7 A,B,C). The EC10 and EC50 determined by the conventional sensory analysis method and by gustometer-assisted sensory analysis method are very close, and not significantly different.

		EC10	EC50
Sucrose	CSA	**11.19**	**115.75**
	GSA	**11.18**	**110.45**
Reb A	CSA	**0.02**	**0.44**
	GSA	**0.04**	**0.46**
Cyclamate	CSA	**0.44**	**3.76**
	GSA	**0.32**	**4,13**

Table 2: EC10 and EC50 values





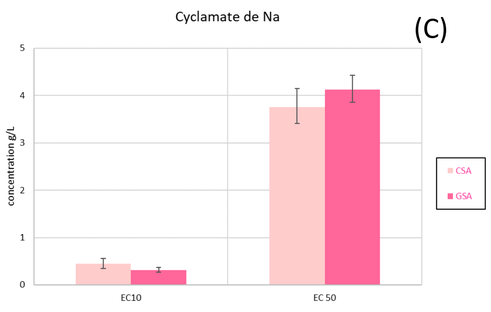


Figure 7: EC10 and EC50 for each sweetner by sensory method

Conclusion

In the end, the whole data collection took almost the same time for the two methods. Whereas CSA was more comfortable for subjects and allowed to test up to 16 subjects in a single session, GSA was allowed to test more samples and to include replicates, which increased results precision. Moreover, GSA required less sample preparation since the gustometer used only a stock solution to perform dilutions automatically, and produced less amount of waste (plastic cups). In conclusion, GSA is a precise method, easy to use for the experimenter, ecologically relevant, and correctly reflects CSA's more usual tasting conditions.

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