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Short Communication

Some sweeteners are tastier than others?! Examining the impact of knowing the type of sweetener on consumers' evaluation of lemonade

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ABSTRACT

Cues related to a product's composition can influence consumer perceptions of food items. For example, information about the type of sweetener used may affect perceptions of healthfulness, caloric content, and expected taste. This study builds on this topic by examining the effect of consumer awareness of sweetener ingredients on their evaluation of lemonade. Participants ($n = 101$) tasted five samples of lemonade (prepared with 15 % pure lemon juice), each sweetened with a different ingredient: sugar, honey, agave, stevia, or saccharine. The samples were either labeled (e.g., "lemonade with honey", experimental condition) or unlabeled (e.g., "lemonade E2W", control condition). We did not find significant differences between the labeling conditions. However, the type of sweetener had a significant main effect across ratings, including evaluation of taste-related (tastiness, sweetness, sourness), health-related (healthfulness, naturalness, calories), and hedonic/acceptance (liking, intentions of future intake, willingness-to-pay) variables. The analysis of correlations between individual differences and lemonade evaluation provides further insights into how the samples were perceived. Specifically, we found a negative association between age and liking of lemonade with sucrose, stevia, and saccharine. Liking lemonades (in general) was positively associated with a preference for the sucrose and agave samples, whereas the preference for sweeter drinks was associated with a higher preference for the lemonade with saccharine. The findings are discussed regarding the implications for the industry and public health.

1. Introduction

In recent years, supermarket shelves have become increasingly filled with products featuring claims about their sugar content (e.g., sugar-free, low-sugar) or the type of sweetener included in their composition (e.g., with coconut sugar or stevia). This trend appears to reflect a growing consumer interest in replacing table sugar (sucrose) with alternatives marketed as more healthful (e.g., honey, agave syrup) or lower in calories (e.g., artificial sweeteners like aspartame or saccharine; for a review, see Singh, Ban, Kashyap, Siraree, & Singh, 2020). Given the evidence associating excessive sugar intake with numerous negative health outcomes (e.g., Huang et al., 2023), it is highly relevant to investigate how consumers respond to sugar-related claims. Research has suggested that nutrition claims related to sugar content (as well as fat and energy content) have the potential to influence the perception of products' healthfulness, appropriate portion size, expected and experienced tastiness, and consumer behavior (e.g., purchase, consumption; for a review, see Oostenbach, Slits, Robinson, & Sacks, 2019).

While the impact of sugar-content claims on consumer perceptions is well-documented, less is known about how the type of sweetener influences these evaluations. For example, Sütterlin and Siegrist (2015) observed that merely adding the word "fruit" when describing the sugar in breakfast cereals enhanced healthfulness perceptions. Similarly, Crown, Rovai, Racette, Barbano, and Drake (2024) found that presenting information about sweeteners (e.g., stevia, sucrose) and their caloric contributions significantly influenced consumers' hedonic evaluations of yogurts.

In one experiment, Prada et al. (2021, Experiment 2) explored how sweetener-related claims affected perceptions across various product categories, including yogurts, ice creams, cookies, and breakfast cereals. Participants were asked to think about products featuring claims about sweeteners of natural origin ("sucrose", "cane sugar", "honey", and "stevia") and rate them regarding the perceived healthfulness, caloric value, and expected taste in comparison with the regular versions. The study revealed a significant main effect of the sweetener claims across all evaluative dimensions, though the direction of influence varied by claim

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type. For example, products with stevia were perceived as the healthiest and lowest in calories but also the least tasty. However, this experiment evaluated claims in the absence of actual products, limiting the ecological validity since participants could not rely on sensory cues.

In the current study, we extend this line of research by examining the effect of revealing (vs. omitting) sweetener-related information on the perception of a specific beverage: lemonade. Specifically, we investigated how the type of sweetener (i.e., sugar, honey, stevia, agave, saccharine) influenced the evaluation of taste-related (tastiness, sweetness, sourness), health-related (healthfulness, naturalness, calories) and hedonic/acceptance (liking, intentions of future intake, willingness-to-pay) variables.

2. Method

2.1. Participants and design

The sample included 101 students (93.1 % women, 5.9 % men, 1.0 % non-binary, M_{Age} = 22.76 years, SD = 6.29) who volunteered to collaborate in this study. Course credits were used as an incentive for participation. Most participants reported following an omnivore diet (86.1 %), and the majority (68.8 %) fell within the normal weight range based on self-reported height and weight.

The experimental design was a 2 (sweetener information: yes vs. no; between-participants) x 5 (type of sweetener: sugar, honey, stevia, agave, saccharine; within-participants) mixed design.

The two groups – those with (N_1 = 51) and without (N_2 = 50) sweetener information – were similar in size and age[1] (M_1 = 23.61; M_2 = 21.94 years). Both had a majority of women (96 % and 90.2 %, respectively) and a high proportion of participants within the normal weight range (66.7 % and 70 %). A detailed sample characterization is available in Supplementary Table 1.

2.2. Materials

Five samples of lemonade per participant were prepared. Each sample included a different type of sweetener (i.e., sugar, honey, stevia, agave, saccharine). Samples were prepared with still water (pH 6.0), packaged pure lemon juice, and liquid solutions of the five types of sweeteners.

All sweeteners were commercially available, and concentrations were adjusted based on values recommended by an expert in nutrition. The five lemonade samples were prepared based on the following concentrations of ingredients: 1 L of still water, 150 g/L (15 %) of lemon juice, and 100 g/L (10 %) of honey, agave syrup, and sugar syrup. The concentration of stevia and saccharin corresponded to 10 g/L (10 %), equivalent to 250 drops. These concentrations were calculated based on a discussion with a nutritionist to determine the ideal concentration levels for each sweetener, aiming for approximate sweetness equivalence. The research team evaluated the resulting samples, but a pre-test was not conducted. The samples were served at room temperature in white, opaque, and disposable paper cups.

2.3. Procedure and measures

This study was approved by the Research Ethics Committee of Iscte – Instituto Universitário de Lisboa (approval #22/2019). Participants were invited to participate in a study about food and beverage perception in the Psychology Laboratory (LAPSO). Participants were pre-screened for food allergies and intolerances. Upon enrolling in the experiment, they were instructed to avoid eating, drinking coffee, brushing their teeth, or smoking the hour preceding the session. Participants were directed to an individual soundproof booth equipped with a computer. All data were collected via a web-based survey programmed in Qualtrics, starting with sociodemographic information (e.g., age, gender). Five lemonade samples (around 20 ml) were served in white paper cups at room temperature (in random order). For about half the participants (n = 51), the samples were labeled (e.g., "lemonade with honey"), whereas for the remaining (n = 50), samples were presented alongside arbitrary codes (e.g., "5AG"). Each sample was evaluated across taste, hedonic, and health-related attributes (with attributes presented in randomized order; see Fig. 1). Taste attributes included sweetness (1 = *Lowly sweet* to 9 = *Highly sweet*), sourness (1 = *Lowly sour* to 9 = *Highly sour*), and overall tastiness (1 = *Lowly tasty* to 9 = *Highly tasty*). Health-related attributes included perceived caloric content (1 = *Lowly caloric* to 9 = *Highly caloric*), naturalness (1 = *Lowly natural* to 9 = *Highly natural*), and overall healthiness (1 = *Lowly healthy* to 9 = *Highly healthy*). To evaluate the hedonic response and acceptance of the samples, we evaluated overall pleasantness (1 = *Lowly pleasant* to 9 = *Highly pleasant*), likelihood of future intake (1 = *very unlikely* to 9 = *very likely*), and willingness-to-pay ("How much would you be willing to pay for a 330ml bottle of this lemonade?", slider between 0 and 3€). Participants were asked to drink water between samples and wait for 30 s (timer presented on screen). After evaluating the five samples, participants were asked to respond to control questions regarding the frequency of use of different types of nutritional information ("*How often do the following sources of nutritional information influence your consumption decisions?*"), namely the a) nutrition facts label, b) ingredients list, and c) nutritional claims (1 = *Never* to 9 = *Always*). With a Cronbach's alpha of 0.811, an index was computed using these three items. Next, we inquired about the frequency of intake of products sweetened with each of the five types used in the experiment (1 = *Never* to 9 = *Always*) and the respective familiarity (1 = *Very unfamiliar* to 9 = *Very familiar*). Moreover, we assessed the general liking of lemonade (1 = *I don't like it at all* to 9 = *I like it very much*), general liking of sweetness in beverages (1 = *Not at all sweet* to 9 = *Very sweet*), and sugar awareness ("How often do you pay attention to your sugar intake?", 1 = *Never* to 9 = *Always;* Hagmann, Siegrist, & Hartmann, 2018). Finally, we asked about interest in health and nutrition (two items, 1 = *Very low* to 9 = *Very high*), type of diet, weight, and height ("*I prefer not to answer*" option included). At the end, participants were thanked and debriefed.

2.4. Data analytic plan

First, we explored the overall evaluations of the samples and the correlations between evaluative dimensions (Section 3.1). To examine the impact of labeling and sweetener, we performed a mixed ANOVA (labeling condition as the independent variable; type of sweetener as the repeated variable) for each evaluative dimension (post hoc tests with Bonferroni correction, Section 3.2). Interaction effects were computed and reported when significant ($p < .050$). Moreover, we explored the association between individual characteristics and overall liking of the lemonade samples (Section 3.3). Lastly, we investigated differences in frequency of intake and familiarity according to the type of sweetener by conducting a repeated-measures ANOVA for each variable (Huyndt-Feldt correction whenever the sphericity assumption was not met, Section 3.4).

3. Results

3.1. Overall evaluations and associations between evaluative dimensions

Participants generally rated the samples as moderately tasty, sweet, and caloric. Liking ratings were also moderate. The samples were evaluated as low in sourness, healthfulness, and naturalness. The likelihood of future intake was also low, as was willingness-to-pay (for descriptive statistics and mean difference tests against the scale midpoint, see Table 1). We observed that tastiness was positively

[1] The mean age did not differ significantly, according to an independent samples t-test, $t(99) = 1.33$, $p = .186$. See also Supplementary Table 1.

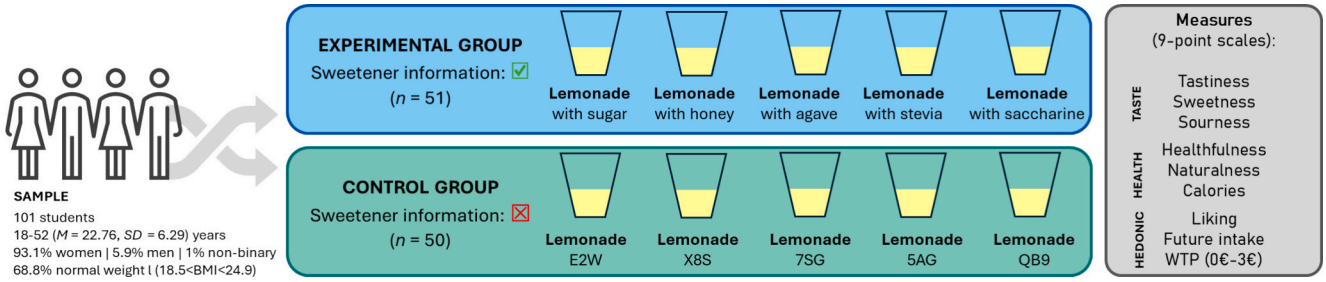

Fig. 1. Schematic Representation of the Procedure.

Table 1
Descriptive Statistics (M, SD) and Correlations (Pearson) Between Evaluative Dimensions.

	M	*SD*	1.	2.	3.	4.	5.	6.	7.	8.
Taste										
1. Tastiness	5.11	(1.25)	–							
2. Sweetness	5.21	(1.18)	0.28**	–						
3. Sourness	4.57[a]	(1.20)	−0.04	−0.45***	–					
Health										
4. Healthfulness	4.64[a]	(1.09)	0.31***	−0.25*	0.28*	–				
5. Naturalness	4.46[a]	(1.09)	0.32***	−0.20*	0.28**	0.75***	–			
6. Calories	5.05	(1.10)	0.30**	0.58***	−0.19	−0.26**	−0.24*	–		
Hedonic / Acceptance										
7. Liking	4.92	(1.23)	0.84***	0.11	−0.04	0.47***	0.47***	0.13	–	
8. Future intake	4.40[a]	(1.40)	0.75***	0.04	0.09	0.37***	0.38***	0.10	0.82***	–
9. Willingness-to-pay	0.95[b]	(0.39)	0.50***	−0.08	−0.02	0.21*	0.25*	−0.10	0.56***	0.62***

[a] Indicates mean ratings that differed significantly from the scales' midpoint (i.e., test value = 5) based on a one-sample *t*-test.
[b] Indicates mean ratings that differed significantly from the scales' midpoint (i.e., test value = 1.5€, $p < .001$). Columns labeled 1 to 8 depict Pearson correlation coefficients.
* $p \leq .050$.
** $p \leq .010$.
*** $p \leq .001$.

associated with all variables except sourness. Sweetness was negatively associated with sourness, healthfulness, and naturalness and positively associated with perceived caloric content. Sourness showed positive associations with both healthfulness and naturalness, which were also strongly associated. Both variables showed negative associations with caloric content and positive associations with liking, future intake, and willingness-to-pay. The latter three variables were also positively correlated.

3.2. Impact of labeling and type of sweetener on products' evaluation

We did not observe significant main effects of labeling conditions on any of the evaluative dimensions, all $p \geq .067$, and all effect sizes were small ($\eta^2_p \leq 0.033$), suggesting that labeling had minimal influence on participants' evaluations. In contrast, the type of sweetener significantly influenced all ratings, all $p < .001$, with moderate to large effect sizes ($\eta^2_p = 0.094$–0.341), indicating that sweetener type played a dominant role in shaping evaluations (see Table 2). Specifically, post-hoc comparisons showed that the honey lemonade obtained the lowest tastiness ratings, all $p < .001$ (no significant differences for the remaining samples, $p = 1.000$). Congruently, this sample was also the least liked, all $p \leq .022$, the least likely to be consumed in the future, all $p \leq .006$ (but not different from saccharine, $p = .758$), and the one rated lowest in willingness-to-pay, all $p \leq .002$ (but not different from saccharine, $p = 1.000$). Saccharine was also rated the least healthy, all $p \leq .020$, and the least natural option, all $p \leq .001$. Interestingly, it was also rated as the least sour, the sweetest, and the most caloric, all $p \leq .001$. All post-hoc comparisons are presented in Supplementary Tables 2a-2c.

Table 2
Descriptive Statistics (M, SD) and Main Effect per Type of Sweetener.

	Sucrose		Honey		Agave		Stevia		Saccharine		Main effect of Sweetener		
Dimension	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*F*(4,396)	*p*	η_p^2
Taste													
Tastiness	5.57	(2.28)	3.83	(2.31)	5.50	(2.25)	5.50	(2.18)	5.15	(2.48)	11.67	< 0.001	0.105
Sweetness	4.14	(1.92)	4.40	(2.35)	4.40	(1.94)	5.82	(2.21)	7.32	(1.87)	51.27	< 0.001	0.341
Sourness	5.17	(2.25)	5.09	(2.27)	5.10	(2.13)	4.46	(2.42)	3.06	(1.97)	18.54	< 0.001	0.158
Health													
Healthfulness	5.23	(1.81)	5.22	(1.98)	5.08	(1.72)	4.25	(1.79)	3.45	(2.02)	21.90	< 0.001	0.181
Naturalness	5.30	(2.09)	4.97	(2.32)	4.80	(2.14)	4.25	(2.12)	3.00	(1.83)	20.38	< 0.001	0.171
Calories	4.40	(1.86)	4.59	(1.87)	4.63	(1.85)	5.19	(1.78)	6.44	(1.78)	25.71	< 0.001	0.206
Liking/Acceptance													
Liking	5.57	(2.22)	3.78	(2.15)	5.26	(2.32)	5.24	(2.33)	4.74	(2.56)	10.23	< 0.001	0.094
Future intake	5.31	(2.64)	3.34	(2.50)	4.86	(2.52)	4.56	(2.64)	3.92	(2.75)	18.62	< 0.001	0.158
Willingness-to-pay	1.11	(0.54)	0.74	(0.52)	1.04	(0.53)	1.00	(0.59)	0.85	(0.67)	10.17	< 0.001	0.109

Note. All evaluative dimensions were assessed using 9-point rating scales except willingness-to-pay (open answer, 0–3€).

No significant interaction between the factors was observed, all $p \geq .178$, except for the healthfulness dimension, $F(4,396) = 2.60$, $p = .036$, $\eta_p^2 = 0.026$, such that when the honey sample was labeled (vs. unlabeled) higher healthfulness ratings were observed.

3.3. Associations between individual differences and sample's hedonic evaluation

As shown in Table 3, we observed negative (and weak) correlations between age and liking for lemonade with sucrose, stevia, and saccharine, all $p \leq .040$. Age was also positively associated with sugar awareness, interest in health and nutrition, and frequency of use of nutritional information, all $p \leq .021$, and negatively with liking for sweeter drinks, $p = .002$.

Positive (and weak) associations were observed for general liking of lemonade and liking for the sucrose and agave syrup samples, all $p \leq .048$. Participants who reported liking sweeter drinks provided higher liking ratings for the lemonade with saccharine, $p < .001$. Liking sweeter drinks was also negatively correlated with sugar awareness, interest in nutrition, and frequency of use of nutritional information, all $p \leq .024$. Finally, interest in health and nutrition and frequency of use of nutritional information were also positively interrelated, all $p < .001$.

3.4. Frequency of intake and familiarity with each type of sweetener

We observed differences in frequency of intake according to the type of sweetener, $F(3.61,356.98) = 22.62$, $p < .001$, $\eta_p^2 = 186$, such that saccharine ($M = 2.80$, $SE = 0.18$) was the least frequently consumed (but not different from agave, $p = 1.000$), whereas sucrose ($M = 5.07$, $SE = 0.25$) was the most frequently consumed (but not different from honey, $p = 1.000$). Likewise, familiarity varied according to type of sweetener, $F(3.81,381.19) = 82.38$, $p < .001$, $\eta_p^2 = 0.452$, such that saccharine ($M = 2.34$, $SE = 0.19$) was the least familiar (but not different from agave, $p = .334$) and honey the most familiar ($M = 7.29$, $SE = 0.20$), all $p < .001$.

4. Discussion

This study investigated whether knowing about the type of sweetener used in a product influences its sensory evaluation and acceptance. The findings indicate that disclosing sweetener information did not significantly alter participants' ratings of the samples' sensory properties (e.g., taste) or their perceptions of healthfulness and hedonic experience. The absence of notable differences based on labeling availability suggests that participants may not have heavily relied on these cues when evaluating the samples or perhaps lacked the necessary familiarity or knowledge about these sweeteners to be influenced by the information (Prada, Saraiva, Garrido, Rodrigues, & Lopes, 2020).

Conversely, as found in previous research (e.g., Crown et al., 2024; Pereira, de Medeiros, Ventura, Pereira, & Bolini, 2022), the type of sweetener significantly influenced sample ratings regardless of the sweetener claim. Furthermore, this effect extended beyond sensory attributes, impacting perceptions related to healthiness and other evaluative dimensions. Notably, saccharin-sweetened samples were rated as the sweetest and least sour but also perceived as the least healthy and natural, with the highest assumed caloric content. This suggests that participants may have inferred a higher sugar content, leading to perceptions of reduced healthiness and increased energy density. Other findings indicate that flavor differences may have had a significant impact on variables that could be influential for product acceptance and, potentially, even market success (e.g., the honey sample obtained the lowest liking and willingness-to-pay ratings). Differences in sweetness evaluations suggest that variations in perceived sweetness intensities may have played a role in how participants assessed the samples. Assuming that sweetness serves as a key factor in product evaluation, standardizing its levels could prompt participants to rely more on other cues, such as sweetener labels. The fact that the solutions were not isointense is a limitation of the current study, therefore, future research should investigate whether controlling sweetness equivalency alters response patterns. Additionally, assessing participants' expectations about sample attributes before tasting could help distinguish labeling effects from those shaped by sensory experience.

The analysis of correlations between the evaluative dimensions offers further insights into the process underlying sample ratings. Some of these associations suggest that sensory cues may indeed be relevant indicators when assessing other attributes, such as healthiness (e.g., sweetness-unhealthiness link; Haasova & Florack, 2019). More generally, we also found evidence of covariation between "positive" attributes, possibly reflecting a halo effect (Laham & Forgas, 2022). Interestingly, this positive covariation was observed even between pairs of variables that are not typically associated, such as healthiness and taste (Raghunathan, Naylor, & Hoyer, 2006). It is possible, therefore, that some of the associations observed here may be related to the sample characteristics. Indeed, some studies suggest that the unhealthy = tasty heuristic may not be equally shared by all cultures (Werle, Trendel, & Ardito, 2013) and depends on individual differences (Haasova & Florack, 2019; Huang & Wu, 2016). Moreover, the fact that we also found associations between healthiness and intentions of future consumption and willingness-to-pay may reflect how participants in this study value

Table 3
Correlations Between Overall Liking Ratings (M, SD) of the Samples and Individual Characteristics (Age, Preferences, and Interest in Health and Nutrition).

	M	*SD*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Sucrose (L)	5.57[a]	(2.22)	–										
2. Honey (L)	3.78[a]	(2.15)	0.21**	–									
3. Agave (L)	5.26	(2.32)	0.11	−0.01	–								
4. Stevia (L)	5.24	(2.33)	0.16	0.10	0.02	–							
5. Saccharine (L)	4.74	(2.56)	0.17	0.17	−0.16	0.25*	–						
6. Age	22.76	(6.29)	−0.23*	0.12	−0.11	−0.23*	−0.21*	–					
7. Liking: Lemonade	6.66[a]	(2.40)	0.22**	0.13	0.20*	0.17	0.05	0.11	–				
8. Liking: Sweet Beverages	5.18	(1.53)	0.06	−0.03	−0.15	0.01	0.45***	−0.31**	−0.06	–			
9. Sugar Awareness	5.32	(2.30)	0.03	0.08	0.09	−0.04	−0.10	0.31**	0.14	−0.27**	–		
10. Health Interest	6.68[a]	(1.67)	0.03	0.02	0.01	0.03	0.01	30**	0.02	−0.11	0.46***	–	
11. Nutrition Interest	5.70[a]	(1.94)	0.00	0.08	0.11	−0.13	0.00	0.23*	0.14	−0.23*	0.59***	0.56***	–
12. Frequency of use Nut Inf	5.09	(2.16)	0.01	0.18	0.05	−0.05	−0.13	0.28**	0.18	−0.32**	0.68***	0.44***	0.51***

Note. Variables 1 to 5 refer to the overall liking (L) of the samples with the five types of sweeteners. Variable 8 refers to the overall liking of sweetness in beverages, and Variable 12 refers to the frequency of use of nutritional information.

[a] Indicates mean ratings that differed significantly from the scales' midpoint (i.e., test value = 5) based on a one-sample *t*-test. All differences were significant at $p < .001$, except for Sucrose Liking, $p = .011$.

* $p \leq .050$.

** $p \leq .010$.

*** $p \leq .001$.

health in their consumption choices. Indeed, participants in this study reported a high level of interest in health and nutrition, which could contribute to a higher disposition to choose healthier products. In future studies, it may be interesting to explore whether similar results would be obtained with different demographics, as the current study was based on a young sample with a large proportion of women.

One of the key contributions of this work was its examination of the effect of sweetener labeling within the context of an actual tasting experience, extending the current evidence to a novel product category (i.e., sweetened drinks). While this approach more closely approximates real-world conditions (including variations in sweetness intensity), it still presents limitations due to the constraints of experimental procedures. For example, to ensure higher internal validity, the samples were prepared following a standardized method in which only the type of sweetener varied, while the main ingredients were kept constant (for a similar procedure, see Wardy et al., 2017). This setup differs from commercial lemonades, which often include additional ingredients such as natural or artificial flavors and other additives. Moreover, the samples were served in conditions that may not reflect how consumers typically consume these beverages (e.g., cup type, temperature). These factors may help explain discrepancies, such as the difference between participants' overall lower liking of the samples and the high reported liking of lemonades in general. Therefore, the interpretation of these results should be made with caution, considering how these samples differ from commercially available lemonades. Concerning labeling manipulation, it is important to note that sweetener information was presented alongside the sample cups. In future studies, it might be interesting to explore alternative ways of displaying sweetener information to more closely reproduce real-world situations, for example, as part of the product packaging (e.g., front-of-pack label). Additionally, replicating this experiment with different products – particularly those raising greater health concerns, such as sugar-sweetened beverages like sodas (e.g., Santos, Gigante, Delpino, Maciel, & Bielemann, 2022) – could provide valuable insights.

In summary, while previous research has demonstrated that sweetener information can impact the evaluation of product categories (Prada et al., 2021), the present study suggests that this influence may be reduced when participants have the opportunity to taste the samples. This may imply that sweetener information primarily affects expectations rather than post-tasting evaluations. These findings contribute to a better understanding of how individuals integrate nutritional information into their assessment of beverages – a question that becomes particularly relevant considering that consumers tend to assign varying healthiness scores to the different sweeteners (Goodman, Vanderlee, Jones, White, & Hammond, 2021). In some cases, the type of sweetener may be a source of bias, potentially leading participants to overlook the potential unhealthfulness of some products.

CRediT authorship contribution statement

Marília Prada: Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization. **David Guedes:** Writing – original draft, Methodology, Investigation, Conceptualization. **Alesia Doros:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Magda Saraiva:** Writing – review & editing, Supervision, Methodology, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2025.105612.

Data availability

Data will be made available on request.

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