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The effect of ballot design for strawberry yogurt analysis using CATA (check-all-that-apply)

Efecto del diseño de la ficha para el análisis de yogurt bebible de fresa por el método CATA (check-all-that-apply)

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ABSTRACT

Sensory evaluation of food is a constantly evolving field, where recently developed analysis methods are on their way to be consolidated. Check-All-That-Apply (CATA) is a rapid method used to describe sensory characteristics of a product through a personalized selection of terms; however, the format in which these terms are presented is not standardized. This study aimed to assess the effect of the design of four CATA ballots for the analysis of strawberry drinkable yogurt. Fifteen descriptive terms were established with the participation of 97 consumers, with 6 terms relating to texture, 5 to taste, and 2 to both appearance and odor. The four ballot models: a) columns, b) vertical list, c) radial distribution, and d) random distribution, were applied to characterize the same commercial brand of yogurt using 150 consumers for each model. According to Cochran's Q test, significant differences were found for the pink color, acid/sour taste, strawberry odor, creaminess, viscosity, milk odor, and artificial flavor. Among the four ballot models, model C shows less variability in selecting terms. Furthermore, there were found differences among the yogurt samples for physicochemical properties (p-value<0.05) related to instrumental color, pH, titratable acidity, and soluble solids, except for consistency index. Finally, these findings highlight that the ballot design affects consumer responses associated with the visual perception process resulting from the design, as well as the physicochemical characteristics of yogurt derived from the technological process experienced during manufacturing and commercialization.

Keywords: CATA; Quality control; Qualitative descriptive analysis; Sensory analysis ballot; Sensory attributes.

RESUMEN

La evaluación sensorial de alimentos se encuentra en constante evolución, donde los métodos de análisis recientemente desarrollados buscan consolidarse. Check-All-That-Apply (CATA) es un método rápido empleado para describir características sensoriales de un producto mediante una selección personalizada de términos. Sin embargo, el formato en que éstos se presentan no está estandarizado. Este estudio evaluó el efecto del diseño de cuatro fichas CATA para el análisis de yogurt bebible de fresa. Se generaron 15 descriptores con la participación de 97 consumidores; de estos descriptores 6 se relacionaron con la textura, 5 con el sabor y 2 tanto con apariencia como con el olor. Se diseñaron 4 modelos de fichas: a) columnas, b) lista vertical, c) distribución radial y d) distribución aleatoria, que fueron aplicados para caracterizar una misma marca de yogurt comercial, empleando 150 consumidores

por cada modelo. La prueba Q de Cochran evidenció diferencias significativas para el color rosado, ácido/agrio, olor a fresa, cremoso, viscoso, olor a leche, y sabor artificial. De las cuatro fichas propuestas, el modelo C mostró menor variabilidad en la selección de términos. Asimismo, los lotes de yogurt presentaron propiedades fisicoquímicas heterogéneas (p-valor<0.05) en relación con el color instrumental, pH, acidez titulable y sólidos solubles con excepción del índice de consistencia. Finalmente, estos hallazgos evidencian que el diseño de la ficha ejerce un efecto significativo en la respuesta de los consumidores asociado al proceso de percepción visual originado por el diseño, así como a características fisicoquímicas inherentes al producto como consecuencia del procesamiento tecnológico y comercialización.

Palabras claves: Análisis descriptivo cualitativo; Atributos sensoriales; Control de calidad; Evaluación sensorial; Ficha sensorial.

INTRODUCTION

Yogurt is a fermented milk originated in the Middle East that is currently produced on an industrial scale and has positioned itself as one of the most massively consumed foods worldwide (Aryana & Olson, 2017; Hashemi Gahruie *et al.* 2015). This food has been widely used as a vehicle to satisfy the functionalities required by consumers, which has resulted in numerous sensory studies (Janiaski *et al.* 2016; Miele *et al.* 2017; Andrade Oliveira *et al.* 2021).

There is a strong interest in the development of rapid sensory methods to increase the efficiency of the data collection process while maintaining the confidence of the information obtained (Meyners & Castura, 2014). In the last decade, multiple rapid sensory profiling methods have been developed as alternatives to traditional descriptive analysis (Fleming *et al.* 2015); such methodologies are shorter, flexible and can be applied to consumers without trained evaluators (Belusso *et al.* 2016). These methods include flash profiling, sorting, polarized sensory positioning (PSP), projective mapping (Napping®), and check-all-that-apply or CATA (Fleming *et al.* 2015; Moussaoui & Varela, 2010).

Check-All-That-Apply (CATA) is a qualitative descriptive analysis method, consisting of multiple-choice questions presented to respondents as a list of words or phrases, from which they must select all the options they believe describe the product under evaluation (Ares & Jaeger, 2015a). Terms may include sensory attributes, hedonic responses, emotional responses, purchase intentions, potential applications, product positioning, among other qualities that the consumer might associate with the sample (Meyners & Castura, 2014).

The CATA terms used can be adopted from previous studies on the product to be evaluated, or they can be generated in an unpublished form. In the latter case, they are obtained from either (1) a trained panel, (2) the opinion of a small number of consumers through "free listing", or (3) generated during focus groups (Fleming *et al.* 2015). Delarue *et al.* (2015) suggest that in CATA studies the number of alternatives usually varies between 10 and 40. However, the use of a short list causes the percentage of selection to increase, while longer lists cause it to decrease. Thus, the results in practice suggest an ideal number of terms in the range of 10 to 28 (Jaeger *et al.* 2015), covering a wide range of sensory attributes (appearance, aroma, flavor/taste, texture, aftertaste/mouthfeel) (Ares & Jaeger, 2015b; Ares *et al*. 2017).

The CATA terms selected should be organized in such a way as to reduce the error by location. Ares & Jaeger (2015a) suggest that the spatial distribution of the terms plays a determining role in the selection process, since the terms located at the beginning are more likely to be selected compared to those located at the end. In the studies conducted using CATA, ballots with a format of two or three columns made up of the terms distributed equally are regularly used. The order of the terms responds to a spatial location on the ballot, and the probability of being chosen is associated with preferences of psychological origin due to the position in which they are found (Blom-Hansen *et al.* 2016).

Considering that the visual layout of the text on the ballot can influence consumers' responses, it was proposed to evaluate the effect of four CATA ballot designs for the analysis of commercial strawberry yogurt.

MATERIALS AND METHODS

Sample. For the generation of descriptors, three of the most representative brands of commercial strawberry yogurt in 1-liter presentations, purchased in supermarkets in the city of Lima, Peru, were used. Brand 1: partially skimmed with strawberry pulp; brand 2: partially skimmed with strawberry pulp and probiotics; brand 3: partially skimmed with artificial strawberry flavor. Subsequently, to evaluate the effect of four ballot models, named as A, B, C and D (Figure 1) the most positioned brand in the market was used. Brand 1: composed of reconstituted milk powder, reconstituted concentrated milk, white sugar, sweetened strawberry pulp, raw milk, hydroxypropyl distarch phosphate (INS 1442), pectin (INS 440), skim milk powder, strawberry and molasses flavorings, carmine coloring (INS 120), zinc source gelatin: zinc sulfate, vitamins A and D, and lactic cultures), according to the ingredient declaration.

CATA evaluation

Generation of descriptors. A total of 97 regular consumers from the university environment were recruited, comprising 41% male and 59% female, aged between 19 and 63 years. Invitations were sent by direct mail and electronic messaging. Twenty-five milliliters of yogurt were served in 2 oz thermal plastic cups at 7 ± 1°C accompanied by table water served in 7 oz plastic cups for initial mouthwash and between samples. Prior to analysis, consumers were given instructions on how to taste the samples and generate terms describing the sensory characteristics of the product through a free listing task based on the order of appearing attributes as follows Appearance → Odor → Taste → Texture → Residual effect, adapted from Dos Santos *et al.* (2015).

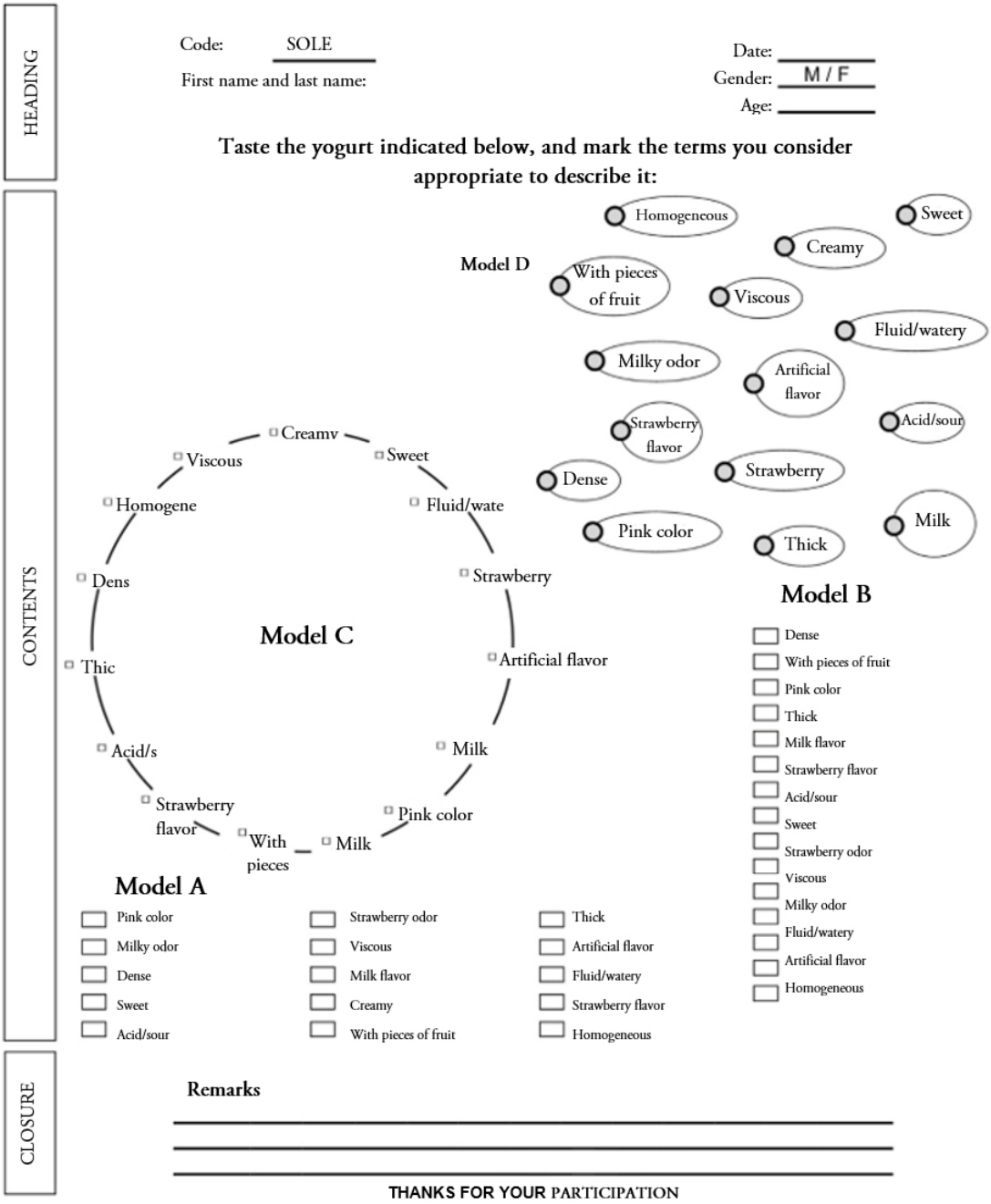

Figure 1. General model of the four analysis ballots: A, B, C and D.
Heading: General data and instruction, Contents: Alternative models according to the case, Closure: Remarks and acknowledgement.

Design of the CATA ballot. With the descriptors generated (693) by the consumers, a frequency matrix of the number of observations of each one was elaborated. The frequency of use of each term was determined by counting the number of times consumers used that term to describe the samples. In the count, terms not appropriate to sensory language were omitted, while similar or synonymous valid terms were grouped together to avoid confusion during the evaluation. Also, words and phrases were adapted to facilitate understanding (Symoneaux *et al.* 2012). This work was conducted by an internal panel of six members with training in sensory evaluation who selected the 15 most frequently mentioned descriptors to obtain good quality data (Jaeger *et al.* 2018) based on a ranking of mentions. These 15 descriptors were organized into four ballot models (Figure 1). Model A: Terms equally distributed in three columns, conventional structure coming from the literature; Model B: Vertical list, to cause the dilution effect of the terms located at the end; Model C: Radial distribution, based on the structure of chromatic circles or color palettes, integrating the terms to facilitate their linkage in sensory profiling; Model D: Random spatial distribution, based on the structure of a word cloud to generate visual dispersion.

CATA sensory analysis. This analysis was performed with the same brand of strawberry drinkable yogurt for the four ballots, with the participation of 600 regular consumers (54% male, 46% female, aged 18 to 69 years) divided into four groups of 150 for each ballot model. The groups performed the delayed analysis in environments adapted for sensory evaluation (Lichters *et al.* 2021). Prior to the analysis, they were instructed to mark with a check or blades all the characteristics perceived in the sample (25 ml), which were served monadically at 7 - 10°C in 3 oz plastic cups without coding.

For data processing, the evaluation ballots were decoded in a matrix as described by Delarue *et al.* (2015), using a vertical format, generating a cell for the combination of consumer and product for each CATA term, which was filled with 1 or 0 to indicate the absence or presence of the attribute, respectively.

The selection efficacy in each model was evaluated considering the total of the 15 descriptors as 100 % using equation 1.

$$Efficacy\ (\%) = \left(\frac{x}{15}\right) \times 100 \qquad \text{equation 1}$$

where "x" is the total number of brands registered according to the model.

Physicochemical characterization of the yogurts

Color. The color of the samples was expressed by applying the three-dimensional CIELab system in terms of L* (lightness), a* (red/green), b* (yellow/blue) and Chroma (C*) using a Minolta CR-400 colorimeter (Japan), after calibration with a white ceramic plate (Ścibisz & Ziarno, 2023). In order to contrast the color difference (ΔE) between commercial samples versus sensory color analysis, equation 2 was used.

$$\Delta E_{Lab} = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2} \qquad \text{equation 2}$$

where ΔL^*, Δa^* y Δb^* represent the mathematical difference between the parameters L*, a* and b*, respectively.

Acidity. Acidity was determined by titration with NaOH (0.1 N) according to *Soukoulis et al.* (2007) and expressed as percentage of lactic acid (g/100 g).

pH. The pH of the samples was determined using a Handylab pH 11 digital portable potentiometer, SCHOTT® (Germany).

Total Soluble Solids (TSS). Soluble solids were determined with an ATC handheld refractometer (0-32 °Brix) according to Yasni & Maulidya (2014).

Consistency Index (K). A dynamic viscosity test of yogurt samples (500 mL) was performed using a Visco Basic Plus rotational viscometer, FUNGILAB® (Spain) with a N° 3 spindle with speeds between 1 to 5 rpm at room temperature (21 ± 1°C). Shear stress and strain rate were calculated to generate rheograms adapted to the pseudoplastic model according to Macedo and Ramírez & Vélez-Ruíz (2015). The consistency index (K) was employed as an indicator of the rheological characteristics of the samples, which was calculated from equation 3.

$$\tau = K\gamma^n \qquad \text{equation 3}$$

where τ is the shear stress, γ is strain rate, *K* is the consistency index and n is the flow index.

Statistical analysis

The CATA data were analyzed using XLSTAT software (trial version), with which the Cochran's Q test was performed to identify significant differences between the ballots for each of the descriptors. In addition, a sensory map was generated from a Correspondence Analysis to visualize the distribution of the attributes according to the samples. Analysis of variance (ANOVA) was carried out on the physicochemical characteristics of the yogurt, followed by a multiple comparisons test using Statgraphics 18 (trial version). All measurements were performed in triplicate.

RESULTS AND DISCUSSION

Descriptors selected for CATA analysis

During the free listing task, 693 valid words or phrases were generated, at a rate of 1 to 16 per person (7 per person on average). Results included duplicate, synonymous, and non-sensory language terms, such as "nutritious", "drinkable", "likeable", among others. It should be noted that the ability to verbalize descriptive terms is associated with the training level of the analyst, as well as with sociocultural patterns of consumption (Xia *et al.* 2020).

The 15 terms selected after screening by the internal panel are shown in descending order according to frequency of mention in Figure 2, from the sixteenth descriptor onwards, the frequencies of mention were less than or equal to 7. Among the selected terms, 6 were associated with texture, 5 with taste and 2 for both appearance and odor. In studies of strawberry yogurt by CATA, the use of 8 to 16 terms has been observed (Castura *et al.* 2016; Cruz *et al.* 2013; De Carvalho *et al.* 2018). Based on these studies, a qualitative comparison of terms was made (Table 1), showing 9 coincidences, while 6 of the selected terms are original to this research. The latter is associated with intrinsic characteristics of the samples originated by their formulation and processing technology, as well as the degree of experience of consumers to verbalize sensory terms, added to sociocultural patterns (Favalli *et al.* 2013).

Ares & Jaeger (2015b) suggest that CATA terms should cover the full spectrum of sensory attributes, ranging from appearance, odor, aroma, taste, texture, to aftertaste. However, within the 15 most mentioned descriptors, those representing aroma are absent, as well as residual sensations given that consumers scarcely generated terms related to these attributes, which reflects the panel's expertise in verbalizing sensory characteristics (Barton *et al.* 2020) and exhibits the predominance of certain attributes over others for yogurt. The

sensory profile achieved can be useful in quality control and in the design and development of new products within this food category.

Effect of the CATA ballot design

During the analysis conducted with the four ballot models, consumers selected an average of 7 terms, with a minimum of 2 and a maximum of 13, conforming to a normal distribution. In this regard, Kim *et al.* (2023) reported an average of 7.7 terms (min.=2 and max.=8) out of a total of 24 CATA terms for commercial yogurts. Each marked attribute is known to indicate that it is appropriate to describe the sample being evaluated, whereas an unmarked term could suggest consumer uncertainty about its applicability (Meyners & Castura, 2014), that they paid little attention to it, or even, that they did not understand it.

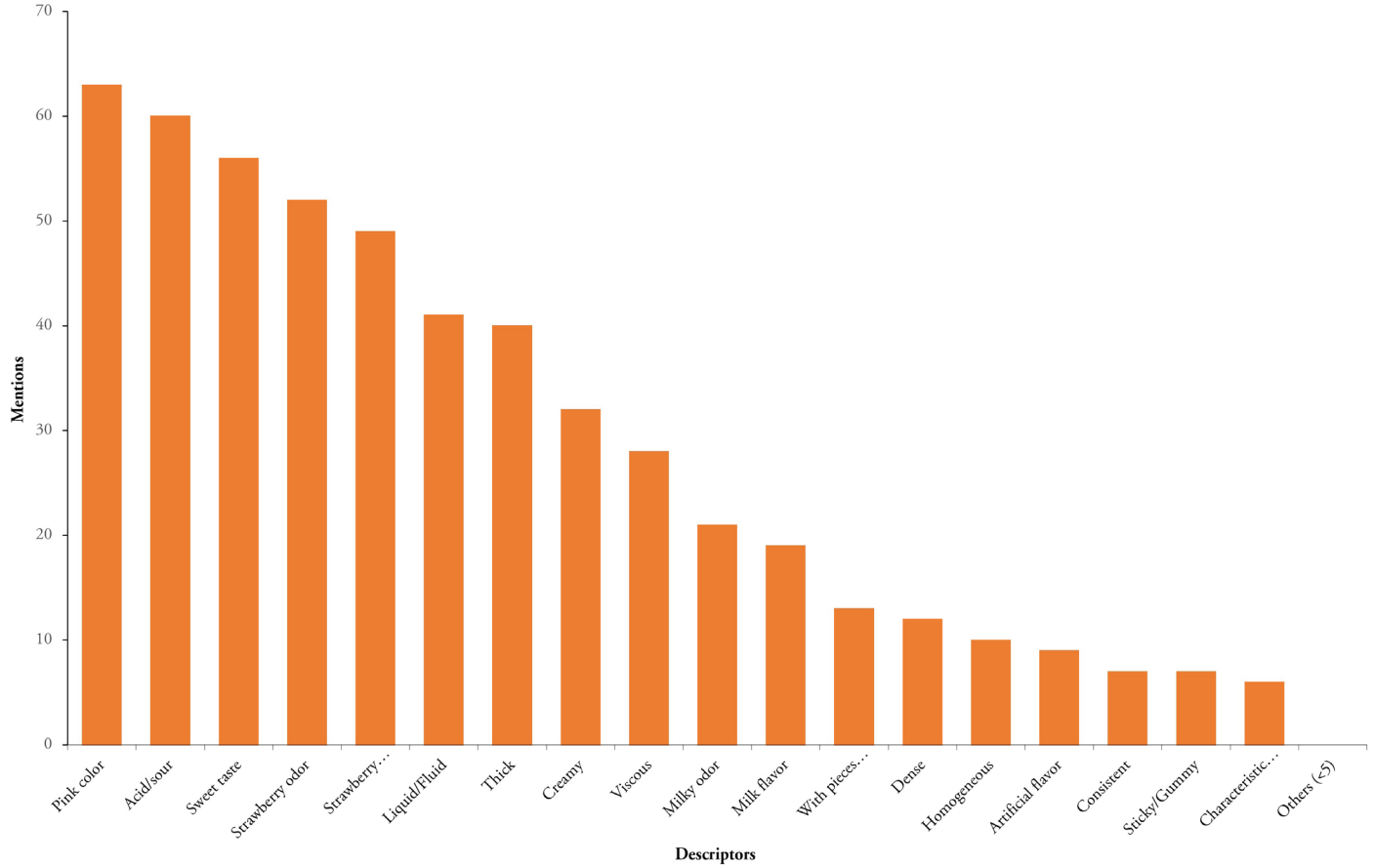

Figure 2. Frequency of descriptor mentions in the term generation phase.

Selection efficacy was employed as a difference indicator, with averages of 44.8%, 47.3%, 44.8% and 42.3%, for models A, B, C and D, respectively. Hypothetically, marking all the descriptors on a ballot would mean that the product has all the characteristics simultaneously, but not necessarily that it is the best. In this study, the terms included in the ballots are associated with the characteristics most commonly found among a triad of commercial yogurts in order to amplify the diversity of descriptors.

According to Cochran's Q test, differences (p-value < 0.05) were found for 7 descriptors (pink color, acid/sour, strawberry odor, creamy, viscous, milk odor, and artificial flavor). This suggests that the design of the ballots impacts the perception of consumers causing them to characterize the properties of yogurt differently. Although these characteristics are the result of the technological conditions of each batch of yogurt, the physicochemical results indicate differences for descriptors with no association such as the consistency index (K), and for some that are related such as instrumental color, acidity index and pH. Also, the apparent homogeneity for the other attributes (sweet, strawberry flavor, fluid/watery, thick, milk flavor, with pieces of fruit, dense and homogeneous) may be attributed to their notoriety, as well as the lack of analyst training (Lawless & Heymann, 2010). Moreover, the same attribute can be understood in different ways by consumers depending on its complexity (Ares *et al.* 2015).

Sensory map

The sensory map (Figure 3) represents the total variation of the experimental data in terms of the first two dimensions (F1 and F2) which explain 89.7% derived from the correspondence analysis performed on the frequency table. A similar study found a value of 90.7% for the sum of the two main dimensions (Delarue *et al.* 2015), values considered valid for the results interpretation. The map reveals the distribution of descriptors according to their frequency of use by each ballot model, evidencing that the design causes consumers to describe differently the same yogurt sample.

Table 1. Comparison of CATA descriptors with other studies using strawberry drinkable yogurt.

This research	Benchmark studies		
	Cruz *et al.* (2013)	De Carvalho *et al.* (2018)	Castura *et al.* (2016)[a]
Pink color	Pink color	Light pink	-
		Pink salmon	
With pieces of fruit	-	Presence of strawberry pulp	-
-	-	Absence of strawberry pulp	-
Strawberry odor	-	-	-
Milky odor	-	-	-
-	Strawberry aroma	-	-
-	Acid aroma	-	-
-	-	Artificial strawberry aroma	-
-	-	Fermented milk aroma	-
-	-	Bitter taste	-
Sweet	Sweet taste	Sweet	Sweetness
Acid/sour	Acid taste	Acid	Sourness
Artificial flavor	-	-	Artificial flavour
Milk flavor	-	-	-
Strawberry flavor	Strawberry taste	Strawberry pulp flavor	Strawberry flavour
-	-	-	Cream flavour
-	Yogurt taste	-	-
-	-	Sweetish	-
-	-	Astringent	-
-	-	Residual sweetener flavor	-
-	-	-	Off flavour
Viscous	Viscous	-	-
Creamy	-	Creamy	Creamy texture
Fluid/watery	-	No consistency	-
Homogeneous	-	-	-
-	Heterogeneous	-	-
-	Liquid	-	-
Thick	-	-	-
Dense	-	-	-
-	-	Consistent with strawberry pulp	-
-	Residual taste	-	-
-	**-**	**-**	Fatty mouthfeel

a TCATA (Temporal check-all-that-apply)

Based on the significantly different descriptors (Cochran's Q test), model B generates a higher number of mentions in the attributes pink color and strawberry odor while ballot D generates a predominance of acid/sour, creamy, viscous, milk odor and artificial flavor. Considering that the distance between points corresponding to products is a measure of their similarity (Ares & Jaeger, 2015a), model D is far from the others and corresponds with having the lowest selection efficacy (42.3%).

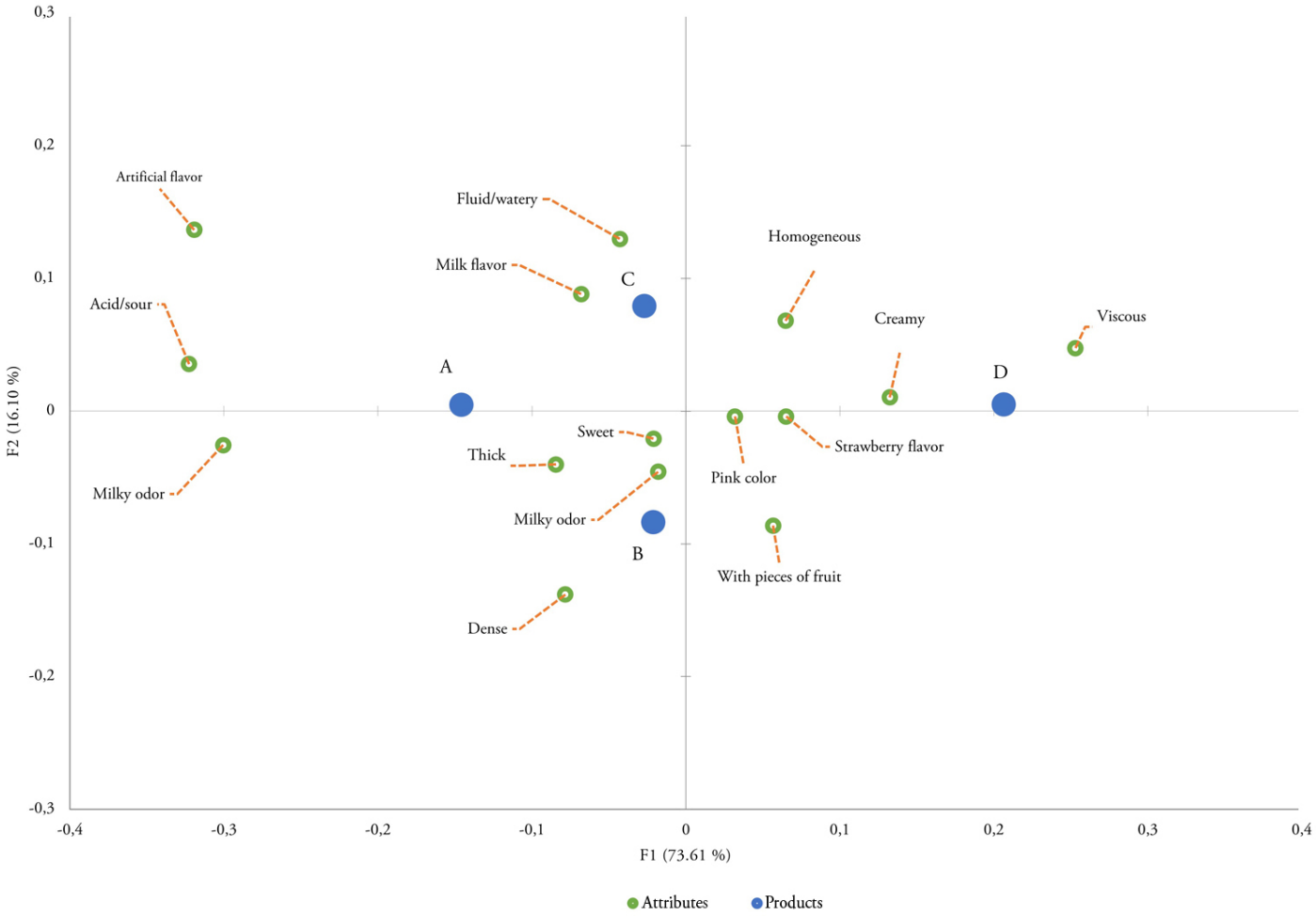

Figure 3. Sensory map of CATA terms for the four ballot models in the analysis of strawberry yogurt.

There are studies that have described a position effect when visualizing a list of alternatives (*Söderlund et al.* 2021). Usually, analysts start reading from top to bottom, incurring in saturation at the end, causing them to have taken greater care in analyzing the first positions. This causes the first terms to be selected more frequently compared to the last ones (Ares & Jaeger, 2015a). On the other hand, the duration of the individual analysis can be an interesting factor to study. In this research, the time to complete the analysis was not measured; however, studies around this factor suggest that the use of long lists causes saturation due to the time invested (Augenblick & Nicholson, 2016).

Effect of samples

The physicochemical characteristics of the yogurt samples showed heterogeneity except for the consistency index (Table 2). Instrumental color had significant differences for the parameters L*, a*, b* and C*, this same variability was observed for the descriptor "Pink color" in the CATA analysis, suggesting that the differences found would not be attributed to the design of the ballots. However, the difference in color between the samples of models A and B (ΔE_{A-B}=1.15 ± 0.22) is insufficient for consumers to be able to differentiate them, given that according to Mokrzycki & Tatol (2011), ΔE should vary between 2 and 3.5 for the difference to be noticeable to the naked eye, as occurs between the samples of C and D (ΔE=2.67 ± 0.27), however, in Cochran's Q test they resulted the same (Table 3). In addition, it is observed that the Chroma had difference in the sample of model D. However, in sensory aspects the different sample corresponds to model B, this is associated with the perception threshold that consumers have regarding the tonality exhibited by the sample in an integral way.

The acidity of the yogurts was heterogeneous ($p < 0.05$), with the sample of model D being higher than the others, and the one with the lowest pH. However, all samples are within the range of 0.6% to 1.5% acidity contemplated by MINAGRI (2017). The inversely proportional relationship that exists between acidity and pH has been reported by Torrico *et al.* (2019) when evaluating strawberry yogurt stored for 28 days at 4°C. It is likely that this behavior derives from a higher production of lactic acid from sugars, which is also reflected by a lower soluble solids content, this phenomenon known as post acidification occurs in the product in storage and marketing stages (Deshwal *et al.* 2021). For this indicator, there is consistency between the physicochemical analysis and the CATA method. Cochran's Q test indicates a difference between two groups, the first group comprising the samples of models A, B and C, against D.

Table 2. Physicochemical characteristics of yogurt samples used in CATA analysis.

Model	Color				Consistency index	Acidity (g/100 g)	pH	TSS (°Brix)
	L*	a*	b*	C*				
A	64.48 ± 0.33^{a}	13.86 ± 0.12^{a}	2.74 ± 0.06^{a}	14.13 ± 0.13^{a}	2.96 ± 0.14^{a}	0.74 ± 0.01^{a}	4.49 ± 0.06^{a}	13.27 ± 0.31^{a}
B	63.89 ± 0.30^{a}	14.02 ± 0.09^{a}	1.82 ± 0.04^{b}	14.14 ± 0.08^{a}	3.10 ± 0.06^{a}	0.76 ± 0.02^{a}	4.61 ± 0.02^{b}	13.33 ± 0.23^{a}
C	65.30 ± 0.29^{b}	13.84 ± 0.08^{a}	1.98 ± 0.01^{c}	13.98 ± 0.08^{a}	2.99 ± 0.15^{a}	0.75 ± 0.01^{a}	4.56 ± 0.01^{b}	13.47 ± 0.12^{a}
D	62.83 ± 0.34^{c}	13.39 ± 0.12^{b}	2.87 ± 0.04^{d}	13.69 ± 0.12^{b}	3.26 ± 0.36^{a}	0.91 ± 0.03^{b}	4.28 ± 0.01^{c}	12.73 ± 0.31^{b}

Table 3. Cochran's Q test and multiple comparisons.

Descriptor	P-value	Ballot model			
		A	B	C	D
Pink color	0.040	0.903 (a)	0.981 (b)	0.916 (ab)	0.929 (ab)
Acid/sour	0.000	0.234 (b)	0.208 (b)	0.221 (b)	0.071 (a)
Sweet	0.064	0.753 (a)	0.799 (a)	0.714 (a)	0.669 (a)
Strawberry odor	< 0.0001	0.578 (a)	0.805 (b)	0.695 (ab)	0.552 (a)
Strawberry flavor	0.130	0.760 (a)	0.838 (a)	0.779 (a)	0.851 (a)
Fluid/watery	0.493	0.214 (a)	0.156 (a)	0.214 (a)	0.175 (a)
Thick	0.184	0.383 (a)	0.364 (a)	0.305 (a)	0.279 (a)
Creamy	0.007	0.526 (a)	0.630 (ab)	0.610 (ab)	0.714 (b)
Viscous	0.001	0.201 (a)	0.318 (ab)	0.344 (b)	0.416 (b)
Milky odor	< 0.0001	0.364 (b)	0.292 (b)	0.260 (ab)	0.130 (a)
Milk flavor	0.279	0.370 (a)	0.305 (a)	0.370 (a)	0.286 (a)
With pieces of fruit	0.273	0.325 (a)	0.383 (a)	0.279 (a)	0.351 (a)
Dense	0.019	0.344 (a)	0.364 (a)	0.227 (a)	0.253 (a)
Homogeneous	0.362	0.545 (a)	0.500 (a)	0.571 (a)	0.597 (a)
Artificial flavor	0.001	0.221 (b)	0.156 (ab)	0.214 (b)	0.071 (a)

The descriptors highlighted in black show significant differences between the models.

Soluble solids ranged from 12.73 to 13.47 °Brix, with the sample of model D having the lowest value ($p < 0.05$). TSS are mainly represented by mono and disaccharides of endogenous origin, as well as added sugars, which are responsible for the sweet taste of yogurt. However, the descriptor sweet was selected without significant differences among the four ballot models (Table 3).

The rheological behavior of the samples was evaluated through the consistency index K ($Pa.s^n$) derived from a fit to the potential model. All samples were statistically equal ($p > 0.05$). Jaster *et al.* (2018) characterized commercial strawberry yogurts finding that they behave as non-Newtonian fluids of Power-law (pseudoplastic) type. In that study, consistency index (K) values were lower (1.217 to 1.577 $Pa.s^n$). In contrast, Wang *et al.* (2019) reported values between 2.02 to 3.22 $Pa.s^n$, similar to this study. According to Macedo & Vélez-Ruíz (2015) the rheological characteristics of yogurt are influenced by the formulation (type of ferments, sugar, stabilizers, as well as the interaction of ingredients), by processing conditions (fermentation time, methods) and storage conditions (time and temperature). The descriptor "Viscous" related to this indicator was different in Cochran's Q test, which reinforces the effect of the ballot model on consumer responses.

The advantages of ballot models include space saving (A), speed of selection (B), innovative design (C) and randomness (D). Disadvantages include positional risk (A and B), visual fatigue (B), space reduction (C) and less clarity (D). The proposed model (C) offers a higher probability of sensory profiling a strawberry yogurt without biases caused by other designs that require randomization, which is a way to guarantee reproducibility and repeatability.

The results obtained reveal that the differences found when describing yogurt derive from the position in which the descriptors appear in each ballot model, as they create a particular psychosensory experience during the selection of the options. Therefore, an effect due to the differences in physicochemical attributes between samples is also included.

As conclusions, the fifteen descriptors selected for the CATA analysis were associated with the characteristics of appearance, odor, taste and texture, while aroma and residual sensations were absent. Significant differences were found for seven of these terms, which are attributable to the model of the ballots, as well as to characteristics of color, acidity, pH and soluble solids that the sample acquires during its elaboration process. Of the four models evaluated, ballot C caused fewer differences with respect to the others, while ballot D offered greater variability in the selection of terms. The findings of this study can serve as a basis for the design of virtual ballots, an increasingly common trend in sensory analysis with consumers. However, for similar and other products it is recommended that modifications be incorporated given the diversity of food categories.

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