Self-CATA: a new consumer test approach with descriptors ranked by Stepwise Discriminant Analysis

Auto-CATA: uma nova abordagem para teste de consumidor com descritores classificados por Análise Discriminante por Passos

Auto-CATA: un nuevo enfoque para las pruebas de consumo con descriptores clasificados por Análisis Discriminante Paso a Paso

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Abstract
The self-CATA test proposed in this study allows consumers an opportunity to supplement the CATA terms with additional vocabulary from a previously generated standard list. Considering that some attributes listed on the CATA test are frequently unselected by consumers because most of them were provided by a previous sensory descriptive panel, even from instrumental or texture parameters, a consensus list to obtain a complete product characterization could be created: a self-own vocabulary list. The work´s design was developed using a CATA-questionnaire containing descriptors provided from a previous panel, ranked by Stepwise Discriminant Analysis to which the consumer's new repertory was added. In this regard, six raspberry gelatin samples were evaluated by 120-consumers using the self-CATA questionnaire. Results indicated eight new consumer features, not previously verified, such as pink color and odd and metallic flavors. The key-point of this study is to verify a significant choice of CATA terminology.
Keywords: Check-all-that-apply (CATA); Discriminant; Sensory; Consumer; Terminology.

Resumo
O teste auto-CATA proposto neste estudo permite aos consumidores uma oportunidade de suplementar os termos do teste CATA com vocabulário próprio adicional, gerados de uma lista padronizada previamente. Considerando que alguns atributos listados no teste CATA não são frequentemente selecionados pelos consumidores devido ao fato de alguns serem provenientes de um prévio painel sensorial descritivo, tanto oriundos de parâmetros instrumentais ou de textura, uma lista consensual para se obter uma completa caracterização do produto pode ser criada: uma própria-auto lista de vocabulários. O desenho experimental foi desenvolvido usando um questionário CATA tradicional contendo descritores provenientes de um painel prévio, classificado pela Análise Discriminate por Passos para cada consumidor, ao qual o novo repertório gerado foi adicionado. Para isso, seis amostras de gelatina foram avaliadas por 120 consumidores usando o novo questionário Auto-CATA. Os resultados indicaram oito novas características de consumo, antes não verificadas, como cor rosa e sabor estranho e sabor metálico. O ponto principal desse estudo foi verificar uma escolha significante de terminologia CATA.
Palavras-chave: Cheque tudo que corresponda (CATA); Discriminante; Sensorial; Consumidor; Terminologia.

Resumen
La prueba de auto-CATA propuesta en este estudio brinda a los consumidores la oportunidad de complementar los términos de CATA con vocabulario adicional de una lista estándar generada previamente. Teniendo en cuenta que algunos atributos enumerados en la prueba CATA son frecuentemente no seleccionados por los consumidores porque la mayoría de ellos fueron proporcionados por un panel descriptivo sensorial anterior, incluso desde parámetros instrumentales o de textura, se podría crear una lista de consenso para obtener una caracterización completa del producto: una autoevaluación. propia lista de vocabulario. El diseño del trabajo se desarrolló utilizando un cuestionario CATA que contenía descriptores proporcionados de un panel anterior, clasificados por Stepwise Discriminant Analysis al que se agregó el nuevo repertorio del consumidor. En este sentido, 120 consumidores

evaluaron seis muestras de gelatina de frambuesa utilizando el cuestionario auto-CATA. Los resultados indicaron ocho nuevas características para el consumidor, no verificadas previamente, como el color rosa y los sabores extraños y metálicos. El punto clave de este estudio es verificar una elección significativa de la terminología CATA.

Palabras-clave: Preguntas marque todo lo que corresponda (CATA); Discriminant; Sensorial; Consumidor; Terminologia.

1. Introduction

One of the most novel techniques that has been developed and usually applies to affective evaluation is the Check-All-That-Apply (CATA) test. CATA has been nowadays used in consumer research to describe the sensory perception in different kind of products, such as ice cream (Dooley et al., 2010), rice crackers, lite bread, cheese, kiwifruit and black currant drinks (Jaeger and Ares 2014), beers (Reinbach et al., 2014), including vanilla ice cream, chocolate, milk desserts and powered drinks (Jaeger et al., 2015), strawberry cultivars (Meyners 2016), wines (Coulon-Leroy et al., 2017), instant and ready-made puddings (Scott et al., 2017), and apple purees evaluated by children (Laureati et al., 2017).

Lazo et al. (2016) discussed which are the most relevant descriptors to be included in term lists, using both CATA and Free Choice Profiling (FCP). They reached the conclusion that CATA performed better than FCP, based on descriptive ability and slightly better regarding the discriminant capacity.

Investigations about how the CATA terms list could be generated is becoming usual in this field: a study exploring rapid profiling methods for determining the useful analysis to attend older adults used a previous discussion meeting to generate the twenty-two terms used on a CATA-list (Scott et al., 2017); A recent research from a Canadian team evaluated some phrases in relation to global food production processes, using a list of word previously generated by a focus group, such as "natural", "safe", "green" and "consumer benefit" (Grygorczyk et al., 2017).

Jaeger et al. (2015) have analyzed 7- consumer studies focusing on the question: how many words/terms should be present on a CATA questionnaire. Their work compared "short" (10-17 terms) vs. "long" (20-28 terms) using new terms, added by creating synonym or antonym words to those present on "short" questions. Across the study, they concluded that the frequency of use on "long" lists decreases, according to adding new synonym or antonym terms ($p<0.05$). This fact should be explained by the idiosyncrasy in consumers' perception, when consumers may select only one word to describe the sample, not any similar term to characterize the same feeling. These comparisons were described on Table 1.

Table 1 - Relation of some previous studies using CATA analysis.

Study sample	Population (n)	Number of terms on CATA question	Term usage (average percentage)	Significant descriptors	How CATA terms were generated?	References
Milk desserts	65 consumers	27	28%	23	Texture terms selected based on a previous free listing study	Ares et al. (2010)
Milk desserts	50 consumers (7 days study)	21	25%	19	Based on results from previous research	Jaeger et al. (2013)
Chocolate	100 consumers (1 day)	40	15%	N/A		
Chocolate	65 consumers (30 days)	40	15%	14		
Chocolate	14 trained panelists (1 day)	40	26%	N/A		
Beers	73 consumers	38	N/A	29	Based on attributes book of beer	Reinbach et al. (2014)
Chocolate	58 consumers	16	37%	14	Based on pilot work and/or previous research using the same product modalities	Ares et al. (2014)
Flavored crackers	95 consumers	16	31%	16		
Flavored crackers	91 consumers	16	29%	16		
Orange-flavored drink	57 consumers	16	30%	15		
Flavored water	93 consumers	14	27%	9		
Apples	119 consumers	15	N/A	15	Based on previous research and preliminary studies	Ares et al. (2014)
Strawberries	110 consumers	21	N/A	18		
Anti aging creams	69 consumers	19	N/A	14		
Chocolate (large difference)	133 consumers	Short list = 12 Long list = 24	Short list =37% Long list = 27%	Short list = 12 Long list = 23	Terms were selected by drawing on previous sensory research by consumers, bench work by sensory professionals and/or trained assessors. For long list: synonyms and antonyms were included	Jaeger et al. (2015)
Milk desserts (small difference)	101 consumers	Short list = 14 Long list = 28	Short list =35% Long list 24%	Short list = 9 Long list = 19		
Cheese (large difference)	134 consumers	Short list = 16 Long list = 24	Short list =30% Long list 25%	Short list = 16 Long list = 24		
Plain crackers (small difference)	99 consumers	Short list = 17 Long list = 28	Short list =27% Long list 22%	Short list = 15 Long list = 19		
Fish	18 trained panel	103	50%	N/A	An extensive bibliographical review was conducted, creating a list of potential fish descriptors. Some additional terms were included from previous sessions.	Lazo et al. (2016)
Apple purees	62 children consumers	11	N/A	7	Generated through a pilot test (free listing) by 10 children and next procedure with experimenters	Laureati et al. (2017)
Wine	14 professionals (CP = classical profiling)	26	N/A	15	Previous study by Lawrence et al. (2013) and some usually terms associated with red wines (Loire Valley) and a survey.	Coulon-Leroy et al. (2017)
	13 professionals (MP = mixed profiling)	8 common terms and more 118 created terms = 126 terms	15%	5 of the 8 common	Focus on the eight common descriptors	
Biscuit	112 consumers (children and teenagers)	16 emotional terms and 14 sensory terms	Emotional terms Blind condition: 23.8% Logo condition: 22.5% Informed condition: 26.6% Sensory terms: Blind condition: 32.5% Informed condition: 32.6%	Emotional terms Blind condition: 15 Logo condition: 12 Sensory terms: Blind condition: 7 Informed condition: 10	Based on previous research, tests and combined the same number of positive and negative emotion terms.	Schouteten et al. (2017)

Source: Authors.

In this way, Coulon-Leroy et al. (2017) came up with "Mixed Profiling" (MP), a new tool of sensory analysis, able to combine the power of predefined descriptors from QDA® and the possibility for each panelist to add their own attributes. They discuss the large number of descriptors generated by a descriptive analysis against the lack of some attributes that can describe accurately some samples, in that case, wines. Results showed that MP avoids the omission of certain attributes and provide a complete sensory wine characterization in a short time. However, some issues can be discussed, such as how the descriptive terms had been chosen for MP application and the large statistical work associated within the new 118 descriptors generated by the wine professionals. A significant attribute in sensory investigation is the one in which evaluation shows systematic and significant differences among the products, allowing, when possible, to create a relationship between the attribute level and the sample sensory characteristics.

Thus, in this study, the qualitative methodology used to investigate the significant attributes generated in a panel was Stepwise DA. This method is based on the identification of the attributes group that maximize the samples difference evaluated by a panel. The higher the difference, the higher the possibility to obtain significant regression models (Fogliatto and Albin 2001).

The main objective of DA is identifying the variables which present better discrimination among the group, based on their characteristics. Aimed at this result, the DA generated discriminant functions (linear combinations of variables) that increase the group's discrimination (Fávero et al., 2009). Rossini et al. (2012) used the discriminant stepwise analysis aiming to reduce the number of attributes in a sensory panel study. The proposed method reduced the number of attributes of meat cubes sensory analysis from 24 to 16, ensuring the accuracy level. In this regard, the study investigated which were the significant descriptors to be appropriate in a complete raspberry gelatin description.

2. Methodology

Six samples of three different brands of raspberry flavored powdered gelatins, currently sold market leaders, were tested. Four of them were sweetened with sucrose (Atra, Btra, Ctra and Dtra) and two were diet variety (Adiet sweetened whit sodium saccharine and sodium cyclamate; Bdiet with aspartame and acessulfame-potassium). All the samples were purchased in supermarkets situated in Campinas/Sao Paulo/Brazil.

The samples of powdered gelatin were prepared by dissolving them completely in 0.25L of boiling water, 0.25L of cold water were added next and homogenized until dissolution was complete. All the samples were stored in refrigerated conditions (6 to 10ºC/24h).

All the sensory studies were carried out with the chilled samples (between 6 and 10ºC). 30mL of each raspberry gelatin samples were presented in disposable plastic beakers coded with a 3-digit number. Tests were carried out in individual air-conditioned booths (22ºC) at Sensory Analysis Laboratory of the School of Food Engineering (FEA/UNICAMP) and evaluated under white light, thus ensuring comfort and privacy for the panelists.

2.1 Descriptive quantitative analysis (QDA®)

Judges with previous experience in descriptive analyses were preselected among Department students and Staff. The judges discussed all generated attributes and ordered a final list with 15 attributes, definitions and references using Kelly's Repertory Grid Methodology (Moskowitz 1983). Then, the panelists were further trained on attributes using these references (total of 6 meetings with 1h duration). Eleven panelists were selected according to their discriminating capability (p>0.30) and repeatability (p< 0.05); consensus between judges was also considered (Damásio and Costell 1991).

The 11-selected panelists were further trained (1h session) and analyzed the samples into four repetitions, using a 9-

cm unstructured line scale anchored with "none" or "weak". The samples in each session were monadically presented using a balanced block design (Macfie et al., 1989). Crackers and taste-free water were provided for palate cleansing.

Firstly, an analysis of variance (ANOVA) was performed on the mean ratings using Tukey´s test with a 5% significance level. The statistical analysis was carried out considering each panelist and their repetitions in the QDA® test using the SAS 9.4 program (SAS, 2013).

The Stepwise model was used for the DA aiming to rank the most important descriptors evaluated by the QDA panel. Wilks´ lambda parameter was chosen to be an inclusion procedure of discriminant variables, using 0.10 as values of significant level to enter and to stay (cutoff inclusion of attributes).

2.2 Self- CATA test

The consumers also evaluated the samples using the CATA questionnaire (Figure 1) with 8 previously sensory QDA attributes, verified by Discriminant Analysis (DA) and other 8 blank spaces. The consumers were asked to select all terms that were related to each sample. The consumer group (n = 120) was composed by students and laboratory staff. The subject selection criterion was to be a regular consumer of gelatin (twice a week).

Figure 1 – Self CATA application test.

Source: Authors.

The order of attributes was balanced using a "to samples" scheme, which allocates attributes ordering the samples, in which each consumer gets a different descriptor order for each sample evaluation, according to Ares *et al.* (2014).

The frequency of mention for each term was determined by counting the number of consumers that select each descriptor, both selected and proposed using self-CATA questionnaire, to characterize the sample.

Cochran´s Q test was also performed for each of the 16 attributes to evaluate significant differences among the samples.

The results were analyzed using Correspondence Analysis (CA) and bi-dimensional maps representing both samples and attributes were obtained. Correlation analysis was carried out using XLSTAT Software 4.02 (Addinsoft, New York, NY) at 0.1%, 1% and 5% significance levels.

3. Results and Discussion

The 11-panel (9 female; 2 male) described the gelatins using 15 descriptors, generated by the QDA® test (Table 2). Results showed that the attribute "bitter aftertaste" was the most characteristic of the diet samples, moreover the firmness was indicated as the parameter with highest value in the Bdiet sample.

Table 2 - Means of QDA® test: traditional/diet raspberry gelatin (n=11 trained panel).

	ATTRIBUTES	Atra[1]	Btra	Ctra	Dtra	Adiet	Bdiet	MDS[2]
APPEARENCE	RED COLOR	4.35^d	6.84^{ab}	5.22^c	6.95^a	4.31^d	6.27^b	0.57
	Brightness	6.63^b	7.15^a	6.87^{ab}	6.88^{ab}	6.89^{ab}	6.78^b	0.31
	Translucency	5.38^{bc}	5.84^{ab}	6.28^a	4.99^{cd}	5.10^c	4.45^d	0.55
Aroma	Raspberry aroma	2.28^d	3.18^{bc}	4.92^a	3.89^b	2.26^d	3.08^c	0.73
	Sweet aroma	2.99^c	4.53^b	6.63^a	6.09^a	3.15^c	4.65^b	0.73
	Cherry aroma	1.58^c	2.01^c	5.38^a	2.92^b	0.70^d	1.80^c	0.60
	Sour aroma	1.27^c	1.33^{bc}	1.99^{ab}	1.59^{bc}	1.11^c	2.40^a	0.69
	Gristle aroma	0.87^{cd}	2.69^a	0.47^d	0.36^d	2.01^b	1.17^c	0.58
Flavor	Raspberry flavor	3.49^c	4.88^b	5.87^a	3.31^c	3.71^c	3.91^c	0.86
	Sweetness	4.60^{ab}	4.76^{ab}	5.18^a	4.81^{ab}	4.55^{ab}	4.17^b	0.78
	Sourness	2.72^a	2.08^{abc}	1.87^{bc}	1.49^c	2.65^a	2.41^{ab}	0.75
	Raspberry flavor	1.09^c	2.59^b	3.44^a	3.80^a	1.54^c	1.35^c	0.69
	Sweet aftertaste	1.68^c	2.48^{bc}	2.62^b	3.28^{ab}	2.53^{bc}	3.87^a	0.85
	Bitter aftertaste	0.78^{cd}	1.05^c	0.43^d	0.78^{cd}	2.94^a	2.29^b	0.49
Texture	Firmness	4.97^c	5.95^b	6.16^b	4.92^c	5.94^b	6.82^a	0.62

[1] Values with different superscripts were significantly different using *Tukey* test (p < 0.05). *Atra, Btra, Ctra* and *Dtra* were traditional commercial raspberry samples (sweetened with sucrose), Adiet and Bdiet were sucrose free versions. [2]MDS (minimum significant difference). Source: Authors.

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Although the sweet aftertaste has been an usual attribute related with diet products, this study showed that even in traditional samples sweetened with sucrose this characteristic was present.

From the DA analysis, the significant attributes were included aiming an identifying the most discriminant variables able to differ the characteristics among the samples. These most significant variables could develop new discriminate models,

which can represent the main differences among the products. Also, the variables could be useful for the development of future classification rules related to sample or group observations.

In the CATA test, the consumers (64% female; 36% male, age between 20-50 years old) evaluated the six raspberry gelatins and the frequency (Table 4) of 16 terms checked by consumers to characterize the samples, as reported in Table 3. The self-CATA-generated questionnaire allowed the consumers to distinguish more assertively the samples in relation to their aroma (raspberry and sweet aroma both $p<.001$), and flavor (sweet $p<.05$, sweet aftertaste $p<.001$, raspberry flavor $p<.001$, sourness $p<.001$, bitterness $p<.001$, artificial flavor $p<.001$, odd flavor $p<.001$, metallic flavor $p<.001$ and astringent $p<.001$).

Significant differences were found in the mentioning frequency for 13 out of 16 terms (81.25%). This value is high when researchers expected the use of assertive terms to generate a CATA list.

Table 3 - Frequency mention of CATA results from all descriptive sensory attributes and self vocabulary (n=120).

	Sensory attributes	Atra[1]	Btra	Ctra	Dtra	Adiet	Bdiet	Total	
					Samples				
Common analysis	Red color n.s.	84	103	94	58	108	97	544	
	Rasparoma***	72	23	27	47	41	59	269	
	Swearoma***	71	32	30	45	57	53	288	
	Sweet*	79	83	87	109	93	76	527	
	Sweet aftertaste***	38	19	21	39	33	30	180	
	Raspflavor***	83	51	58	78	71	66	407	
	Firmness n.s.	94	93	94	92	80	95	548	
	Translucency n.s.	82	83	93	83	57	84	482	
Self vocabulary	*Pink color***	6	2	4	31	3	0	46	
	*Sourness***	2	12	17	7	6	16	60	
	*Bitterness***	1	7	7	0	4	7	26	
	*Artificial flavor***	2	6	2	3	1	3	17	
	*Odd flavor***	0	7	4	0	4	3	18	
	*Metallic flavor***	1	0	2	1	0	1	5	
	*Astringent***	2	0	0	0	0	1	3	
	*Brightness***	1	2	1	1	1	0	6	

n.s., non-significant difference according to Cochran´s Q test. significant difference for *$p<.05$. **$p<.01$.***$p<.001$. *[1]Atra, Btra, Ctra* and *Dtra* were traditional commercial raspberry samples (sweetened with sucrose), *Adiet* and *Bdiet* were sucrose free versions. Source: Authors.

According to Table 4, an important result could improve the relevancy of a consumer own term generation: pink color was a descriptor not mentioned in the panel discussion to describe the raspberry gelatin samples. However, pink color appears as a significant attribute on the self-CATA analysis. In addition, all of the self vocabulary created by the consumers during the CATA evaluation, was significant ($p<.001$).

**Table 4** - Stepwise DA results from QDA® descriptors.

Step	Entered Variable	Partial R^2	F Value	Pr > F	Wilks' λ	Pr < λ
1[1]	**Raspberry aroma**	**0.3744**	**22.98**	**<.0001**	**0.62**	**<.0001**
2	**Red color**	**0.3637**	**21.83**	**<.0001**	**0.39**	**<.0001**
3	**Sweetness**	**0.2216**	**10.82**	**<.0001**	**0.31**	**<.0001**
4	**Firmness**	**0.1967**	**9.26**	**<.0001**	**0.25**	**<.0001**
5	**Sweet aftertaste**	**0.2140**	**10.24**	**<.0001**	**0.19**	**<.0001**
6	**Sweet aroma**	**0.1486**	**6.53**	**<.0001**	**0.17**	**<.0001**
7	**Translucency**	**0.1373**	**5.92**	**<.0001**	**0.14**	**<.0001**
8	**Raspberry flavor**	**0.1511**	**6.59**	**<.0001**	**0.12**	**<.0001**
9	Cherry aroma	0.1184	4.94	0.0003	0.10	<.0001
10	Bitterness	0.1044	4.27	0.0011	0.09	<.0001
11	Sourness	0.0938	3.77	0.0029	0.09	<.0001
12	Brightness	0.0582	2.24	0.0527	0.08	<.0001
13	Gristle (cartilage	0.0695	2.69	0.0228	0.08	<.0001
14	Bitter aftertaste	0.0793	3.08	0.0108	0.07	<.0001
15	Cherry flavor	0.0583	2.20	0.0560	0.06	<.0001

Atra, Btra, Ctra and *Dtra* were traditional commercial raspberry samples (sweetened with sucrose), Adiet and Bdiet were sucrose free versions. [1]Descriptors in bold font were the most significant to describe the samples. Source: Authors.

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Firmness, for example, an attribute noted by the QDA panel with a significant difference between the Bdiet from the other samples, was a non-significant term cited by consumers on the CATA test. This result could imply a question about whether the real parameter could better characterize the product expectation, aiming to reach a high acceptance level. The sourness was a significant (p<.001) attribute, able to characterize the product. this is an interesting point because sourness was analyzed in the 11th step across DA. The self-CATA questionnaire did not introduce this parameter as a mandatory term. Nevertheless, it was generated by consumers and indeed used to discriminate the gelatin samples. In an earlier study (Palazzo, Bolini, 2011), sourness was able to differentiate (p<.05) the Bdiet and Dtra samples from the others (in relation to maximum intensity of acid flavor), using time-intensity analysis, another descriptive analysis which aim of characterizing samples at the time of consumption.

According to Figure 2, the percentage of inertia explained by the first two dimensions of CA was 85.5% and the chi-square coefficient was 0.96. The two-diet samples were located together, in a distant quadrant from the others, characterized by terms expected in this kind of products: red color and sweet aroma.

Figure 2 - Representation of the terms in the first and second dimensions of the Correspondence Analysis performed on data from check-all-that-apply (CATA) self-question (n = 120 assessors; 5% significance level, *Atra, Btra, Ctra* and *Dtra* were traditional commercial raspberry samples sweetened with sucrose, Adiet and Bdiet were sucrose free versions.
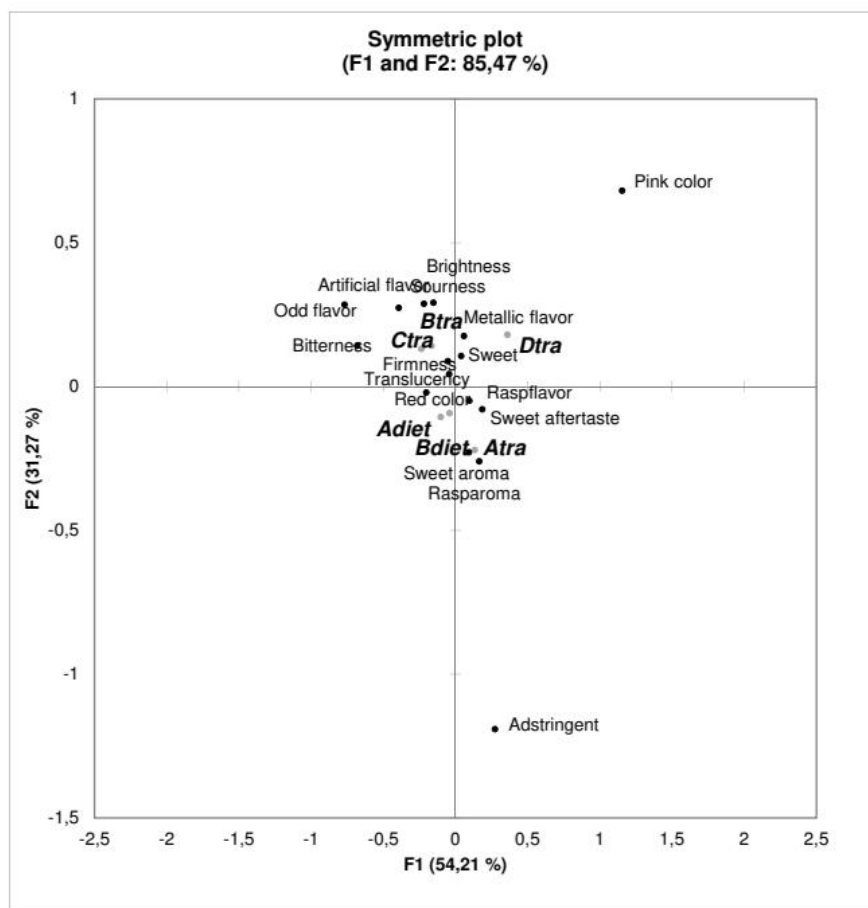
Source: Authors.

Reinbach *et al.* (2014) compared the CATA methodology with Napping® using eight different beers. They concluded that the precision and reproducibility of sensory data obtained by consumers is similar between the two techniques. However, CATA is faster, less labor-intensive and more suitable, considering a large consumer group.

Even for identifying children's perception, the CATA is suitable: Laureati *et al.* (2017) studied sixty-two children between 8 and 11 years old using a CATA questionnaire and concluded they were able to generate appropriate descriptive words and discriminate fiber enriched apple puree samples. Furthermore, they suggest that CATA could be an interesting and rapid approach to get an insight on how younger people evaluate sensory characteristics, suggesting the facility and practicality to use this test with this age group.

Across the study, the number of significant terms used in the CATA analysis was investigated, aimed to respond to the main question on how to generate an ideal and assertive list, using a number of terms that are able to describe the sample without consumers' fatigue. Thus, using the self-CATA with 8 previous terms and 8 blank spaces, the consumers used an average of 31% of the total possible words. These results are relevant compared with other studies such as the data obtained by Jaeger et al. (2015), in which values between 22 to 43% of the use of the terms by consumers were found, also when comparing different products analyzed by Jaeger et al. (2013), with an average term usage between 15 to 26%, and for dairy

desserts, with a mean of 28%, according to Ares et al. (2010).

This value is higher when compared to Lee's et al. (2013) study, which reported that consumers used 17% of all words available on a 26-CATA list associated within flavor attributes; the mean usage of terms for the evaluation of biscuits using terms from the CATA test was 7 out of 14 under blind condition and 10 out of 14 under informed condition, according to Schouteten et al. (2017).

Considering some issues previously noted, the next issues need to be discussed: (1) how have the descriptive terms been chosen for MP application. In Coulon-Leroy's et al. (2017) work, a short term of 8 descriptors was chosen based on the most important attributes, previously studied in other research using different wines. In our contribution, the same product was used in a complete QDA® test (n=11) to generate the entire characterization. Then, DA was applied to verify the significant attributes that could better discriminate the gelatin. This mechanism results in a complete attribute generation, based on a decisional statistics performance. (2) the large statistical work associated within the new 118 descriptors generated by the wine professionals by Coulon-Leroy *et al.* (2017). On the other hand, our study used 120 consumers to evaluate the samples, not a descriptive panel or specialist / professionals. The choice of a real consumer analysis provides results easily associated with others industry areas, such as marketing.   Considering the consumers' answers, the statistical treatment allowed a less in-depth analysis of the comments contingency table by identifying the more or less significantly attributes among the products. Then, the consumers' evaluation corroborated to generate similarities among the terms during the self-CATA, besides completing the characterization of the product.

Another question that remained unaddressed involving the CATA questionnaire is how to generate terms that consumers easily understand and how many words should be present on a CATA list.

Jaeger's *et al.* (2015) investigation addressed the second question, working with two different groups of CATA tests: using a "short" list against a "long" term list, across seven studies. The answer of the investigation pointed to a "dilution" effect on citation frequency, associated with an idiosyncrasy in the consumers' evaluation. They suggest that the longer the list, the more tedious to the consumer, damaging the selection of greater characteristics to describe the product. And it is important to note that the main concept of CATA approach was associated with popular words to facilitate the consumers' analysis. Another study related that consumers may not select some words because they consider them "irrelevant" or "inappropriate" (Ares et al., 2013). Thus, these findings showed that a 16-term list generates a significant and consensual discussion of the product, presenting a friendly questionnaire to consumers in general.

Lazo et al. (2016) concluded that on average CATA selected attributes were higher than FCP because probably the consumers perceived it was easier as more terms were presented to them. This fact turns the evaluating simply and practical, compared with analysis in which the assessors have to generate their own descriptors. However, this work created an alternative to optimize the generation of terms (not very long and extensive), providing blank spaces so that the consumers could activate their own memory process. According to Johnson (2010), the phenomenon of neural processing can be activated in two ways: through recognition activities (when information is available among different choices) and through recall processes (people must generate their own answers and this process needs to activate more brain areas). Self-CATA provides these two inputs to the assessors: the recognition process occurs (they analyzed which terms were more correlated with the sample in a compact and assertive list) and it also works with the recall development, working on more brain areas and creating new words to better characterize the product.

Thus, this important question may be answered by Self-CATA. Thereunto, the combination of DA to create a discriminant list of attributes able to completely describe the product (based on a sensory panel) with a space to create where the consumers can relate their perception could be a recent progress to improve the gained momentum of CATA methodology.

4. Conclusion

These findings confirm that rapid consumer methods, such as CATA methodology, are suitable to capture differences among samples and understand the consumers' perception, independently of the assessor's age group. Nevertheless, a preliminary study about the used terms has to be discussed. In this point of view, a self-CATA questionnaire could facilitate and minimize the hard labor of scientific sensory appliers.

The self-generated terms associated with a previously analyzed descriptors list could create a wide apparatus to characterize better the parameters. In this way, the terms used could be more assertive for the CATA application test.

Thus, future investigations could be approach, varying the descriptors, number of attributes and type of food, aiming more comparison using this new scale.

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References

Amerine, M. A., Pangborn, R. M. & Roessler, E. B. (1965). *Principles of sensory evaluation of food. New York: Academic Press.* 602p.

Ares, G., Giménez, A. & Bruzzone, F. (2010). Identifying consumers'texture vocabular of milk desserts. Application of a check-all-that-apply question and free listing. *Braz. J. Food Technol. 6th Sensiber*, 98-105.

Ares, G., Barreiro, C., Deliza, R., Giménez, A. & Gámbaro, A. (2010). Application of a Check-all-that-apply question to the development of chocolate Milk desserts. *J. Sensory Stud. 25*, 67-86.

Ares, G., Jaeger, S. R., Bava, C. M., Chheang, S. L., Jin, D., Giménez, A. & Varela, P. (2013). CATA questions for sensory product characterization: Raising awareness of biases. *Food Quality and Preference*, 30(2), 114-127.

Ares, G., Tárrega, A., Izquierdo, L. & Jaeger, S. R. (2014). Investigation of the number of consumers necessary to obtain stable sample and descritor configurations from check-all-that-apply (CATA) questions. *Food Quality and Preference*, *31*, 135-141.

Coulon-Leroy, C., Symoneaux, R., Lawrence, G., Mehinagic, E. & Maitre, I. (2017). Mixed Profiling: a new tool of sensory analysis in a professional context. Application to wines. *Food Quality and Preference*, *57*, 8-16.

Damásio, M. H. & Costell, E. (1991). Descriptive sensory analysis: descriptors generation and collectors selection. *J. Agr. and Food Techol. 31* (12), 165-178.

Dooley, L., Lee, Y. S. & Meullenet, J. L. (2010). The application of check-all-that-apply (CATA) consumer profiling to preference mapping of vanilla ice cream and its comparison to classical external preference mapping. *Food Quality and Preference*, *21*, 394-401.

Fávero, L. P., Belfiore, P., Silva, F. L. & Chan, B. L. (2009). Análise de dados: modelagem multivariada para tomada de decisões. *Rio de Janeiro: Elsevier*.

Fogliatto, F. S. & Albin, S. L. (2001). A hierarchical method for evaluating products with quantitative and sensory characteristics. *IIE Transactions. 33(12)*, 1081-1092.

Grygorczyk, A., Jenkins, A., Deyman, K., Bowen, A. J. & Turecek, J. (2017). Applying appeal ratings and CATA for making word choices in messaging about food technology. *Food Quality and Preference.*

Jaeger, S.R. & Ares, G. (2014). Lack of evidence that concurrent sensory product characterization using CATA question bias hedonic scores. *Food Quality and Preference*, *35*, 1-5.

Jaeger, S. R, Beresford, M. K., Paisley, A. G., Antúnez, L., Vidal, L., Cadena, R.S., Giménez, A. & Ares, G. (2015). Check-all-that-apply (CATA) questions for sensory product characterization by consumers: Investigations into the number of terms used in CATA question. Food Qual. Pref. *42*, 154-164.

Johnson, J. (2010). Designing with the mind in mind simple guide to understanding user interface design rules. Chap 9, 109-117, 2nd Ed, Elsevier, Waltham, USA.

Laureati, M., Cattaneo, C., Lavelli, V., Bergamaschi, V., Riso, P. & Pagliarini, E. (2017). Application of the check-all-that-apply method (CATA) to get insights on children´s drivers of liking of fiber-enriched apple purees. *J. Sensory Stud. 32*, 1-9.

Lazo, O., Claret, A. & Guerrero, L. (2016). A Comparison of Two Methods for Generating Descriptive Attributes with Trained Assessors: Check-All-That-Apply (CATA) vs. Free Choice Profiling (FCP). *J. Sensory Stud.* 31(2), 163-176.

Lee, Y., Findlay, C. & Meullenet, J. -F. (2013). Experimental consideration for the use of check-all-that-apply questions to describe the sensory properties of

orange juices. *Int. J. Food Sci. Techn. 48*, 215–219.

Macfie, H.J., Bratchell, N., Greenhoff, K. & Vallis, L.V. (1989). Designs to balance the effect of order of presentation and first-order carry-over effect in halls tests. *J. Sensory Stud. 4* (2), 129-148.

Meyners, M. (2016). Testing for differences between impact of attributes in penalty-lift analysis. *Food Quality and Preference*,*47*, 29-33.

Moskowitz, H. R. (1983). Product testing and sensory evaluation of foods. *Food and Nutrition Press.* 605 p.

Palazzo, A. B. & Bolini, H. M. A. (2009). Multiple time-intensity analysis and acceptance of raspberry-flavored gelatin. *J. Sensory Stud. 24*, 648-663.

Reinbach, H. C., Giacalone, D., Ribeiro, L. M., Bredie, W. L. P. & Frost, M. B. (2014). Comparison of three sensory profiling methods based on consumer perception: CATA, CATA with intensity and Napping®. *Food Quality and Preference*, *32*, 160-166.

Rossini, K., Anzanello, M. J. & Fogliatto, F.S. (2012). Selection of attributes in descriptive sensory analysis. *Production J. 22* (3), 380-390.

Sas System for Windows (Statistical Analysis System). (2013). *Version 9.4 SAS Institute Inc. Carry.* NC. USA.

Schouteten, J. J., Steur, H. D., Lagast, S., Pelsmaeker, S. D. & Gellynck, X. (2017). Emotional and sensory profiling by children and teenagers: A case study of the check-all-that-apply method on biscuits. *J Sensory Stud. 32* (1), 1-11.

Scott, N., Grygorczyk, A., Gilbert, C. C. & Duizer, L. M. (2017). Exploring the use of rapid profiling techniques for use in older adult populations. *Food Quality and Preference.*

Xlstat. (2006). Xlstat 2006. *Help. Addinsoft Inc.* Paris. France.