

Short Communication

CATA Method to Obtain Additional Information for Sensory Shelf-Life: Is It Wise to Discard Terms?

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INTRODUCTION

Consumers are the most important tool in determining the shelf-life of a product [1,2] because it depends on the interaction between the food and the consumer. The acceptability limit is one of the methods used for sensory shelf-life evaluation, and it involves the estimation of sensory shelf-life based on consumer acceptability data, collected using a hedonic scale [1]. Shelf life is defined as the time at which the first significant difference in acceptability scores is obtained, that is, the time when the hedonic perception of consumers changes significantly [2].

In addition, CATA (check-all-that-apply) questions includes a series of structured questions that are presented in a questionnaire format, where panelists see a list of terms from which they select all the characteristics that apply to a certain sample [3]. It has not been used to obtain additional information in sensory shelf-life studies with consumers.

On the other hand, in other methods of sensory evaluation, terms are discarded when the information is analyzed. For example, when the free word association (FWA) technique is applied, all terms are grouped into categories and dimensions, and the dimensions that do not obtain 5% or 10% frequency of mention are discarded. This is probably done because the terms with the highest frequency of mention are the best descriptors of the product under study. The use of CATA questions has not been used for studies over time. If the product properties change during the storage period, the terms that best describe it can be expected to change. Therefore, it is relevant to ask whether the terms may be discarded in CATA data analysis. The aims of this research were a) to determine whether more information is obtained on the characteristics of a product throughout their shelf-life by applying the CATA test than when using only the

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Submitted: 28 November 2023

Accepted: 27 December 2023

Published: 29 December 2023

ISSN: 2333-6706

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acceptability test; and b) to study the effect of the discarded terms on CATA analysis and results.

This work allowed us to know the benefits of applying CATA to study the shelf-life of a product and to determine whether it is convenient to modify the usual data analysis for the discarded terms. The food product chosen to study the proposal was a cereal bar.

METHODS

Sensory shelf-life determination

Acceptability limit methodology: The shelf-life of the cereal bar was studied using the acceptability limit methodology according to a basic design [1,4] at six different times during storage: fresh sample (t0), at 20 (t1), 40 (t2), 87 (t3), 108 (t4), and 155 (t5) days. The overall liking of the product was tested using a 9-point hedonic scale for each shelf-life time.

Sensory characterization: CATA test: The CATA test was used for characterizing the product at each shelf-life time. Thirty-eight simple and easy-to-understand terms were selected [5] from the bibliography Capella, Arruti et al. [6], Olivera et al. [7], and verified at a meeting with members of Instituto de Investigaciones Sensoriales de Alimentos (IISA). The terms were as follows: cereal smell, adhesive to the teeth, moist, dry, gummy, sweet, bitter, cereal taste, honey taste, rancid, hard, soft, attractive color, soft taste, strong taste, diet, conventional, soft smell, homemade, handmade, healthy, compact, strong smell, delicious, fresh, good quality, sticky (on the hands), cloying, greasy, industrial, boring color, strange taste, crumbly, poor quality, disgusting, product for athletes, product for children, and product to consume between meals.

All sensory tests were performed at IISA (ISO 8589:200732 standard). Six hundred cereal bar consumers (164 male, 436 female, aged 18–60 years) were selected. The samples (20g) were presented on a plastic plate and coded with a random three-digit number. Participants tasted each sample once (no replicates) [5]. Mineral water was provided for them to rinse their mouths. This study was approved for the use of human subjects by the Bioethics Commission of UNSa (Res. CD-213-20).

Statistical analysis

The acceptability limit was calculated according to Hough and Fiszman et al., [8]. A regression line of the mean overall liking as a function of the storage time was plotted. The end of shelf-life, namely the time at which the acceptability score reaches the acceptability limit [1,2], was calculated from the regression equation.

In tests where the consumer perception is inquired, some terms whose frequency of mention is less than a certain percentage (e.g. 5% or 10%) are usually discarded. In the present research, we proceeded as follows: 1) no terms were discarded (all terms); 2) terms with less than 5% frequency of mention were discarded (<5% discarded); 3) terms with less than 10% frequency of mention were discarded (<10% discarded). The CATA data was analyzed using the Cochran's Q test [9] to identify different attributes among the different storage times, and the Wilcoxon sign test was conducted to identify significant differences among terms used to describe the bars at different storage times. Simple Correspondence Analysis (SCA) was constructed for each group of terms: all terms, < 5% discarded, and <10% discarded (data not shown). All statistical analyses were performed using Infostat 2016p and RStudio, with $P < 0.05$.

RESULTS AND DISCUSSION

Acceptability limit methodology

The acceptability limit was 6.8 on the hedonic scale. The regression analysis between the average values of global acceptability and the storage time ($r^2 = 0.84$) allowed us to estimate the end of the sensory shelf-life at 128 days.

The fresh cereal bar had an overall liking mean of 7.40 ± 0.11 ("like moderately"). The average acceptability decreased significantly ($p < 0.05$), as expected, over the storage time (data not shown). The decrease was remarkable from t0 (0 days) to t1 (20 days) and from t4 (108 days) to t5 (155 days).

CATA data analysis

Most terms changed over time (data not shown), according to the CATA test: the products with a longer storage time were defined using negative terms, indicating an obvious negative effect of time with an increase in the perception of sensory defect by consumers.

Analysis of CATA data containing all terms: An increment of the 'gummy', 'compact', 'strong smell', and 'strange taste'

attributes was detected over time. However, the bar was perceived as 'sweet', 'attractive color', 'soft smell', 'healthy', 'delicious', 'product for children', and 'to consume between meals' at times t0–t2 (0–40 days).

The bar contained ingredients composed of mono and polyunsaturated fatty acids, which over time may experience oxidative rancidity and compromise the product quality, causing pigment discoloration, changes in the smell and in taste texture. This leads consumers to perceive a cereal bar as 'rancid' at the end of its shelf-life [10]. All these changes had a negative impact on the hedonic response to the product, reducing the perception of a 'delicious' product. It also influenced the perception of 'healthy' product, which surely led the consumers to think that, as the storage time went by, the product became less suitable 'for children' or 'to consume between meals'. Moisture gain was surely responsible for the gummier nature of the product.

No differences were perceived in connection with the following features over time: 'dry', 'bitter', 'cereal taste', 'honey taste', 'soft taste', 'soft', 'hard', 'conventional', 'handmade', 'cloying', 'industrial', 'poor quality', and 'disgusting'. 'Conventional' and 'handmade' characteristics did not show changes ($p < 0.05$) probably because of the appearance of the ingredients; in particular, popcorn is the most visible and common ingredient used in Argentinian cereal bars. The use of this ingredient could be responsible for the perception of a 'handmade' cereal bar.

The inertia of the first two dimensions of SCA of the CATA analysis of cereal bars at different shelf-life times, including all terms, explains 71.2% of the data variation (data not shown). The bars were positioned in shelf-life order as follows: t0, t1, t2, t3, t4, and t5 along the first dimension. At t0, the fresh bar was highlighted as being a 'moist', 'healthy', and 'good quality' product, 'for children' and 'to consume between meals'. After 20 days (t1), the product was described with the following terms: 'soft', 'honey taste', 'handmade', 'attractive color', and 'cereal smell'. Forty days later (t2), the bars were perceived as 'adhesive to the hands', 'delicious', and 'dry'.

During the first 40 days of shelf-life (t0 to t2), the consumers described the bars using terms related to the ingredients, highlighting beneficial properties and positive sensory characteristics. These results were similar to those found by Ribeiro et al., who observed that consumers associated this type of term with a cereal bar considered ideal.

Eighty-seven days later (t3), the cereal bar was perceived as having a 'soft smell' and being a 'sweet', 'conventional', and 'crumbly' product. At t4 (108 days after manufacture), it was described as 'sweet', with a higher frequency of mention of the terms 'soft smell', 'compact', 'soft' and 'boring color' than at the previous storage time. At t5 (155 days), the cereal bar was rated less frequently with the terms 'cereal smell', 'attractive color', 'soft smell', and 'sweet' than at the previous storage times. It was also described as little 'healthy', of 'good quality', and an appropriate product 'to consume between meals'. In addition, the cereal bar was rated as 'rancid' and as having a 'boring color' more frequently than previously.

From t3 to t5, the bars were believed to be 'adhesive to the teeth' and to have a 'strange taste'. It is important to note that at t4 and t5 (108 and 155 days), the product was perceived as 'gummy', with a 'strong smell', and not suitable 'for children'. From these results, it could be stated that in the last three times (from 87 days onwards), consumers clearly perceived deterioration reactions in the product.

Analysis of CATA data excluding the terms with less than 5% frequency of mention at all studied times: The SCA without the terms that did not reach 5% frequency of mention at all studied times was an inertia of the first two dimensions of 79.5% of the data variation (data not shown). For this analysis, the following terms were discarded: 'industrial', 'hard', 'bitter', 'greasy', 'disgusting', 'poor quality', 'adhesive to the hands', 'oversweet', 'rancid', and 'strong smell'. The terms 'hard', 'poor quality', 'rancid', and 'strong smell' were only mentioned at t4 and t5. At time 0, the description of the cereal bar was similar to that found when all terms were used. In this analysis, after 20 days of storage (t1), the cereal bar was termed 'crumbly', and 20 days later (t2) it was perceived as

'adhesive to the teeth', 'fresh', and a product 'to consume between meals'. The analysis of the last three storage times showed that the cereal bars were associated with the same terms as in the analysis that included all the terms, except for the terms discarded.

Analysis of CATA data excluding the terms with less than 10% frequency of mention at all studied times: The SCA showed that the first two dimensions explain 80.3% of the data variability (data not shown). The following terms were discarded, together with those eliminated in the previous analysis: 'dry', 'diet', 'strong taste', 'delicious', 'boring color', 'strange taste', and 'product for children'. Therefore, all concepts related to the deterioration of the product over time were deleted, that is, they were not used for describing the products at any shelf-life time, even when the deleted characteristics were present.

The consumers' feedback on the cereal bars was similar to that obtained from the previous analysis (less than 5%). The bars were not associated with terms that denote defects or deterioration because all those terms had been deleted from the questionnaire.

Although the first two dimensions explain greater data variability, this does not reflect the changes undergone by the product. In other words, the fewer terms included in the analysis and the greater data variability explained in the SCA increasingly failed to reflect what the consumer really perceived.

How did discarding terms affect the results?: CATA has recently been applied to characterize products, like oils, at different storage times. The authors analyzed CATA data in the traditional way, using all the terms, and concluded that this method provided valuable information on the oils at different storage times. In the present research on cereal bars, in which the terms with less than 5 and 10% frequency of mention were

removed from the analyses, a great deal of important information for describing the products at different times was lost.

In another test, such as FWA, the words with less frequency of mention were discarded. This is done under the premise that only the first association elicited by each consumer would provide new and relevant information [11].

Accordingly, we expected the main characteristics chosen by consumers to describe the cereal bars to be the most relevant ones, leaving those least mentioned without effect. However, in a shelf-life study where the characteristics of the products change over time, excluding some descriptive terms in one or more sampling occasions results in the loss of useful information for differentiating the products.

Thus, terms such as 'attractive color', 'soft smell', 'healthy', 'delicious', 'product for children' and 'to consume between hours' were mentioned for describing fresh products, while 'adhesive to the teeth', 'strange taste', 'gummy', 'strong smell' and 'rancid' were selected especially for describing cereal bars with a longer storage time. This example confirms the importance of consumers as a useful tool to evaluate the changes in food over time, but if their perception is censored by eliminating concepts that they use to describe food, then their feedback is not meaningful. Therefore, how did discarding terms affect the results? The answer is that they should not have been ruled out.

CONCLUSION

The acceptability limit test indicated that after 128 days, there was a significant decrease in acceptability with respect to the fresh product. Acceptability decreased as storage time elapsed; with changes in taste and texture (the cereal bar became softer and gummier). This work allowed us to obtain information about changes in characteristics of products with different storage times, and it can be concluded that it is very useful to complete a shelf-life study exclusively with consumers and using the CATA test to obtain more information than when using only the acceptability limit methodology. Concerning the CATA data analyzed, discarding terms is not recommended for shelf-life sensory analysis, since valuable information may be lost. In particular, the consumers would miss the opportunity to reveal their true perceptions given the absence of appropriate terms to describe the product at the end of its shelf-life.

Funding

This work was supported by PIP2022-543; PICT 2021-225 and CIUNSa B 2790/0

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