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Understanding the sensory profile of cheese ripeness description by trained and untrained assessors

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Abstract

Cheese ripeness is an important step of cheese manufacturing that provides a kind of food with complex sensory characteristics and nuanced differences. The importance of generating rapid/easy consumer perception of a new product is without question. The aim was to evaluate the Santo Giorno cheese sensory profile, at different ripening times and with different starter cultures, evaluated by trained assessors and consumers using CATA questions. The two methods generated similar results. However, the results from CATA revealed that consumers are able to discriminate between cheeses with different ripening times but not describe them in detail. The application of the technique also made it possible to perceive that the two starter cultures used did not reflect different sensory elements and that the spicy and salty attributes are more easily perceived by consumers when evaluating ripened cheeses.

Keywords: CATA; QDA; regional cheese; Santo Giorno.

Practical Application: Generating rapid/easy consumer perception of a product is a strategy to improve new food development.

1 Introduction

Cheese is one of the main products manufactured from milk in developing countries. Due to their diversity of manufacturing procedures, cheeses are considered a complex dairy product, with wide variations in chemical composition (Ali et al., 2022; Messias et al., 2022). Such characteristics make them foods rich in nutrients, being important sources of quality proteins, vitamins, minerals, and lipids. Even the intake of saturated fatty acids from cheese has been associated with beneficial health promotion (Feeney et al., 2021).

In Brazil, the state of Paraná is in third place in milk production. Due to the importance of the dairy sector the regional cheese called Santo Giorno emerged in the southwest mesoregion (Brandielli et al., 2020; Pereira et al., 2017). Among the factors related to cheese production, the ones that most influence the final sensory characteristics are the starter cultures used in the formulation and the ripening times (Özer & Kesenkaş, 2019).

Quantitative Descriptive Analysis (QDA) is possibly the most sophisticated sensory method used for the complete characterization of foods (Santos et al., 2022). This analysis allows measuring the sensory impression of a given product in both qualitative and quantitative terms, through unstructured scales assigned by trained assessors. Even so, with the objectives of: i) reduction of time related to selection and training of tasters; ii) taking into account the direct perception of consumers; and iii) evaluation of products in a holistic way, with new methods of sensory characterization appearing in recent years. These methods are characterized by being fast, flexible, and directly applicable by consumers (Varela & Ares, 2012).

Therefore, the role of sensory methods in the food industry for quality control and product development is unquestionable. The importance of generating rapid/easy consumer perception of a new product is also without question. For the dairy industry, this understanding is no different and for this reason groups of researchers have dedicated themselves to exploring the sensory perception of dairy products through consumer techniques (Cais-Sokolińska et al., 2021; Los et al., 2021; Rodrigues et al., 2021a; Rodrigues et al., 2021b; Ruvalcaba-Gómez et al., 2020).

Among the new descriptive sensory methods, Check-All-That-Apply (CATA) is a simple and promising tool to characterize foods. In this technique, consumers are given a list of words or phrases, and they are asked to mark all the options that describe each sample. The idea is that the frequency of mentions of the words/sentences in the questionnaire is directly related to the intensity of the attribute, although it does not provide quantitative information since consumers only evaluate whether or not the term describes the product (Ares et al., 2015; Varela & Ares, 2012).

CATA questions have been used with success for the sensory characterization of many food products, including dairy products

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(Rodrigues et al., 2021a; Steinbach et al., 2021). Although, the success of applying the CATA technique when compared to the results obtained by trained panels has been proven, Ares et al. (2015) noted that the product characterizations were less similar in studies where samples were most similar and/or complex. With a focus on samples that are similar/complex, the present study had the objective of comparing the application of two sensory profiling techniques: Quantitative Descriptive Analysis (trained assessors) and CATA questions (consumers) as tools for evaluation of Santo Giorno cheese sensory profile after different ripening times and with different starter cultures.

2 Materials and methods

2.1 Autochthonous starter cultures, manufacture and ripening of cheese

The autochthonous strains were provided by Bioagro Societá Partecipata de Veneto Agricoltura, Italy. They were isolated from milk obtained in southwestern Paraná, Brazil. Two different lyophilized autochthonous starter cultures were used, due to the industrial need for culture rotation. Autochthonous starter culture A was composed of strains of *Streptococcus thermophilus* ST28 and ST128 and strains of *Lactobacillus delbrueckii* sp. bulgaricus LB134. Starter culture B was composed of the same microorganisms, but the strains of *Streptococcus thermophilus* were different (ST98 and ST104) (Brandielli et al., 2020). The cheese, called Santo Giorno, was manufactured at a dairy farm in southwestern Paraná, following the production process described by (Brandielli et al., 2020).

2.2 Sensory assessments

The Santo Giorno cheese samples were prepared with two different starter cultures (A and B) and ripened for two periods (60 and 120 days) (total of 4 samples). Each was sensorially described by a trained panel using Quantitative Descriptive Analysis and by consumers, through the Check-all-that-apply method. Participants were provided with an informed consent form at the beginning of the tests. The sensory assessment was submitted to the human research ethics committee of the SISNEP System, and approved under opinion number 1.675.757.

2.3 Samples

For sensory assessment, the cheeses were cut in half and then further divided into samples with 2 cm^3 after removal of 1.5 cm of rind. The samples were kept at room temperature (23 °C) in a glass jar covered by plastic film for a maximum of 15 min in order to avoid changes in the characteristics. Random 3-digit codes were used, and a randomized balanced design was applied for sample tasting.

2.4 Description of cheeses by the trained panel – quantitative descriptive analysis

The four cheese samples were assessed by a selected and trained panel (n = 9), which was previously submitted to triangular tests of aroma recognition, discrimination of basic tastes, texture classification (ISO 8586 2012) and trained for correct use of the scale, notions of proportion, and recognition of typical aroma and flavor attributes of ripened cheeses. An initial list of 17 attributes was generated. Factor analysis was applied to reduce the list to the most representative terms describing the samples. The final list consisted of 7 descriptors, assessed on unstructured scales of 9 cm.

The tests were conducted in the UTFPR-FB Sensory Analysis Laboratory, in standard sensory booths that were designed in accordance with ISO 8589 (International Organization for Standardization, 2007).

2.5 Description of cheeses by consumers – check-all-that-apply

The CATA questions included 14 sentences. For each statement, an opposite sentence was presented, to obtain more trustworthy results. The sentences noted the same sensory characteristics assessed by the descriptive analysis method. The attributes were presented in different orders for each sample and for each participant, as indicated by Ares et al. (2014).

Responses that marked both the statement and its opposite were discarded. The responses of 333 consumers, aged 20-65 years, were inserted in the database. The application of the test took place in a supermarket located in the southwest region of Paraná.

2.6 Data analysis

Analysis of data from trained assessors

The individual performance of trained assessors was checked using ANOVA. "Sample" was considered a fixed source of variation while "session" was considered random effect. The panel's performance was checked by calculating the mean of each session. Assessors whose responses did not differ statistically ($p \leq 0.05$) from each other by the Tukey mean comparison test were selected for the final trained sensory panel. Principal component analysis (PCA) was performed on the covariance matrix of the attribute scores averaged across assessors, using a matrix data set with 4 columns (cheese samples) and 7 rows (attributes).

Analysis of CATA data

The frequency of use of each sentence was determined by counting the number of consumers that checked that term to describe each cheese sample. Cochran´s Q test was performed to identify significant differences among samples for each sentence. Correspondence analysis (CA) was used to determine the association between CATA sentences and cheese samples using a matrix data set with 4 columns (cheese samples) and 14 rows (CATA sentences).

Comparison of data from trained assessors and consumers

Sample configurations from the two methodologies were compared by calculating the RV coefficients between sample coordinates in the first two dimensions of the PCA/CA (Antúnez et al., 2017). The significance of the RV coefficient was tested using an extrapolation test using XLStat 2020.1.3.

3 Results and discussion

3.1 Comparison of cheese sample configurations

Figures 1-2 show the configurations of cheese samples evaluated by trained assessors and consumers. PCA and CA were the two chemometric tools used to explore the arrangements. PCA is considered one of the most important statistical techniques, as it is versatile, and its primary function is to help understand data tables in order to obtain an overview (Granato et al., 2018; Næs et al., 2010). CA is another widely used tool. It is a technique of interdependence in which the primary advantage is the ability to represent rows and columns on a perceptual map (Bordim et al., 2021; Hair et al., 2009).

It is possible to verify that the percentages of variance explained by the two dimensions for both PCA and CA presented good results. With 98.38% of explained variance of the axes, CA results of the CATA data were slightly higher. The difference in the percentage of information contained in the first two dimensions of the PCA (2.36%) was also observed across most of the studies presented in the work of Ares et al. (2015). The authors suggested that sample configurations obtained with consumers by CATA tended to be more one-dimensional than those obtained by trained assessors using QDA, explaining the greater explanatory power of the first two dimensions. Sample configurations were also compared by calculating the RV coefficient based on the first two dimensions of each method. The value of 0.997991 ($p \leq 0.001$) revealed a good correlation of configurations (Antúnez et al., 2017).

In addition to the good explanatory power revealed by the first two dimensions, another important result for both configurations was the separation between cheese samples with different ripening times, 60 and 120 days. In both graphs, the ripening time was explained by the first and largest dimension. An interesting response, especially regarding CATA data, was that consumers perceived differences in the Santo Giorno cheese samples with different ripening times. These differences are consequences of the occurrence of proteolysis and lipolysis during ripening. These reactions are responsible for changes in color, texture, aroma, and taste (Khattab et al., 2019). During cheese ripening, proteinases and peptidases degrade casein peptides into free amino acids in the same way that milk lipids are hydrolyzed to medium- and short-chain fatty acids. Amino acids and fatty acids in free state contribute to the formation of flavors and textures and serve as substrates for the production of other flavor compounds (Tekin & Güler, 2019).

The absence of difference in sensory description revealed that both starter cultures were able to produce Santo Giorno cheese, information that is very important for cheese production. While it well known that the characteristic cheese flavor is developed during ripening, a consequence of the metabolic activity of the starter culture during fermentation and their enzymes during ripening (Tekin & Güler, 2019), the option of using two starter cultures to produce the same cheese is of great value, considering the possibility of problems related to inactivation by bacteriophages (Attorni et al., 2014).

Although the most important results of the two methods were very similar in regard to the description of Santo Giorno cheese samples at different ripening times, QDA was more efficient. This result corroborates the previous findings of Ares et al. (2015), that product characterization from CATA questions was less similar to the classic descriptive analysis in studies where samples were

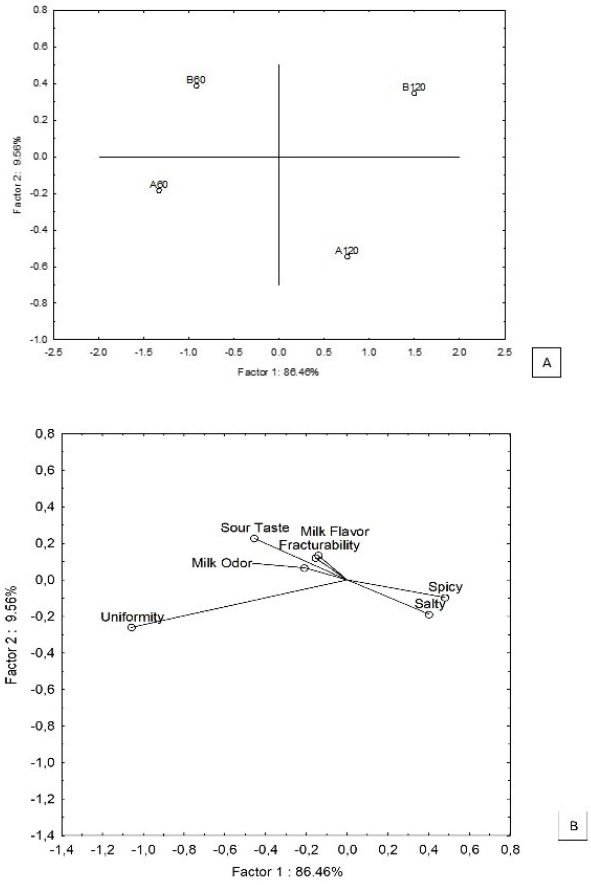

Figure 1. Representation of samples (A) and sensory attributes (B) in the first two dimensions of principal component analysis performed on data from trained assessors.

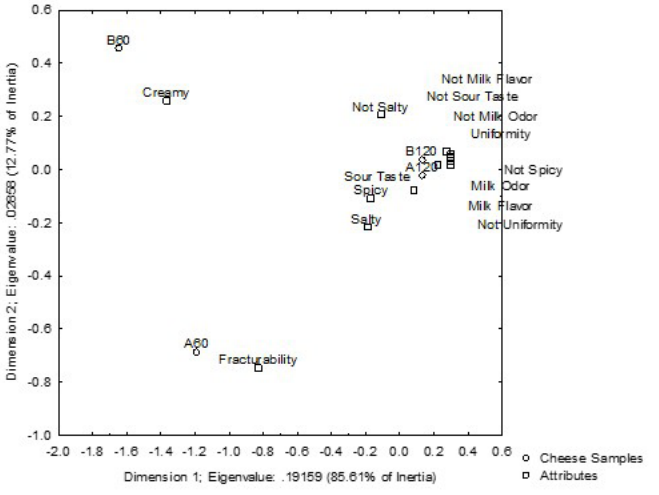

Figure 2. Correspondence analysis performed on data from CATA questions with consumers.

Table 1. Frequency (%) with which the sentences of the CATA questions were used by consumers to describe the cheese sample, and results from Cochran´s Q test for comparison between samples.

Attributes	*P*-valor	B60	A60	B120	A120
Salty	< 0.0001	6.3[a]	11.7[b]	48.3[c]	58.3[d]
Not Salty	< 0.0001	5.7[b]	1.2[a]	29.7[c]	28.8[c]
Spicy	< 0.0001	2.4[a]	3.3[a]	20.1[b]	16.5[b]
Not Spicy	< 0.0001	0[a]	0[a]	27.9[b]	28.8[b]
Uniform	< 0.0001	0[a]	0[a]	49.5[b]	47.4[b]
Not Uniform	< 0.0001	0[a]	0[a]	9.3[b]	13.2[b]
Milk Odor	< 0.0001	0[a]	0[a]	18.3[b]	21.9[b]
No Milk Odor	< 0.0001	0[a]	0[a]	22.2[b]	19.5[b]
Sour Taste	< 0.0001	0.9[a]	1.8[a]	19.2[b]	20.7[b]
No Sour Taste	< 0.0001	0.3[a]	0[a]	25.8[b]	24.0[b]
Milk Flavor	< 0.0001	0.6[a]	0.6[a]	25.2[b]	29.4[b]
No Milk Flavor	< 0.0001	0[a]	0[a]	18.3[b]	15.9[b]
Creamy	0.004	15.0[b]	7.2[a]	14.4[b]	13.2[b]
Fracturability	0.050	1.2[a]	3.3[ab]	3.9[ab]	4.8[b]

Rows with different superscript letters differ signficantly ($P \leq 0.05$).

more complex and detailed nuanced differences were needed. For the present study, the degree of detail of the characterization of the four cheese samples by consumers was low, making it impossible to get a profile. The results were different from those found by the trained panel, where the samples with 120 days of ripening were described mainly by the salty and spicy attributes, while those ripened for 60 days were described by attributes of fracturability, acid taste, uniformity, milk odor and milk flavor.

The CA of the CATA results showed no separation for each attribute and its opposite in the same sample, and also that the attributes were concentrated near those of the samples with 120 days of ripening.

This behavior can be better understood when analyzing the contingency table data (Table 1), which shows the frequency of superior mentions for the samples with 120 days of ripening, regardless of the statement (opposite or not). It should be reiterated that for the 333 consumers who participated in the CATA questionnaire, when they indicated a statement and its opposite to characterize the same sample, the response was disregarded.

Although the configuration of CATA data did not provide detailed information on the characterization of cheese samples, it is possible to verify differences between the samples by Cochran's Q test.

4 Conclusion

For the present work, the description of the Santo Giorno cheeses, ripened for 60 and 120 days, was not detailed by consumers from CATA questions. This suggests that CATA questions answered by consumers might not be an optional method if the objective of the study is to obtain a detailed sensory profile of cheeses with different ripening times.

Nevertheless, the two methods generated comparable results. It was clear that both groups, trained tasters and consumers, differentiated between the cheeses ripened for 60 days from those ripened for 120 days. Another important response to the assessment of the configurations was the possibility of varying the two starter cultures without impairing the sensory characteristics of the Santo Giorno cheese.

Conflict of interest

The authors declare no conflict of interest.

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