Original Article
Food Science and Technology

ISSN 0101-2061 (Print)
ISSN 1678-457X (Online)

DOI: https://doi.org/10.5327/fst.00230

Sensory and instrumental texture profile: a study of wafer-type biscuits from different commercial brands

Adrielle Borges de ALMEIDA[1], Thayanara Mayara de LIMA[1], Daiane Costa dos SANTOS[1], Josemar Gonçalves de OLIVEIRA FILHO[1], Ariadne Ribeiro LODETE[1], Daniele Silva LIMA[1], Daiane Sousa PERES[1], Déborah Souza OLIVEIRA[1], Mariana Buranelo EGEA[1*]

Abstract

Sensory analysis is applied in different sectors of the food industry, facilitatingthe evaluation of qualitative and quantitative aspects of food. Among these aspects, texture, defined as the mechanical, geometrical, and surface properties of a product, perceived by visual, tactile, and auditory human receptors, is an indispensable parameter in the preparation of biscuits. The present study aimed to define the texture profile of six different brands of wafer-type biscuits. For the pre-selection of the judges, the triangular test was applied, and the judges who discerned different samples went on to the training. The training consisted of setting four attributes, namely, fracturability, adhesiveness, chewability, and hardness. Food was served as reference standards, from the least intense to the most intense for each attribute. In the descriptive test, samples were served individually and the judges were asked to explain their initial perception, chewing experience, and residual sensations. The hardness test was performed on a texturometer by compressing the samples and the instrumental results were compared to the sensory findings. Out of 30 judges in the triangular test, 22 were able to participate in the training, only 12 attended, 9 succeeded 80% of the standards, thus participating in the descriptive test. Comparing the instrumental part with the response of the sensory analysis, a good correlation was observed, with the same divergences between some brands. The C sample was considered by the judges as intermediate, and the same as the hardness with higher intensity, the E sample obtained similar results for both evaluations, where it presented a hardness parameter varying from weak to intermediate.

Keywords: fracturing; adhesiveness; chewiness; toughness.

Practical Application: Relationship between sensory and instrumental texture profile of biscuits was reported.

1 INTRODUCTION

Texture parameters play a crucial role in assessing and controlling the quality of processed foods. Sensory texture analysis enables the identification and thorough examination of the sensory quality of food, based on sensory data collection methodologies and statistical methods for evaluating and interpreting the results of the sensory study (Mihafu et al., 2020).

Descriptive sensory analysis is applied to characterize the sensory properties of a food product, where qualitative and quantitative aspects related to appearance, aroma, flavor, and texture attributes can be evaluated, also indicating the degree of intensity of each attribute in the food (Gámbaro et al., 2021; Świąder & Marczewska, 2021). Compared with conventional sensory evaluation, the instrumental method offers reliable and rapid characterization of various textural properties of foods (Grossmann et al., 2021).

Among these attributes, texture is essential in the manufacture and acceptability of biscuits to consumers (Di Cairano et al., 2021). The term texture is difficult to define, as it can be evaluated both sensory and instrumentally, and the correlation between these methods has already been used to compare relevant sensory characteristics (Savouré et al., 2021).

Food texture has been defined by International Organization for Standardization (ISO) in its standard vocabulary for sensory analysis as all rheological and structural (geometric and surface) attributes of a food product perceptible through mechanical, tactile, visual, and auditory receptors (ISO, 2008). The texture is also related to the sensations experienced as food is transformed in the oral cavity (Devezeaux De Lavergne et al., 2021; Liu et al., 2022).

Biscuits are products obtained by the convenient kneading and baking of dough prepared with flour, starches, fermented or non-fermented starches, and other food ingredients (Šmídová & Rysová, 2022). These products have been used as vehicles to add new ingredients to the diet that may be more nutritious or provide benefits to human health (Egea et al., 2023; Goswami et al., 2021). Changes in the formulation of biscuits, as well as in

Received 22 Nov., 2023.
Accepted 25 Jan., 2024.
[1]*Instituto Federal de Educação, Ciência e Tecnologia Goiano, Rio Verde, Goiás, Brazil.*
*Corresponding author: mariana.egea@ifgoiano.edu.br
Funding: CNPq, FAPEG, CAPES (001), and IF Goiano.

the process, can result in changes in the texture profile perceptible to consumers, underscoring the importance of defining a sensory profile for each type of product (Davidov-Pardo et al., 2012; Dourado Gomes Machado et al., 2021). Thus, the objective of this work was to evaluate the texture profile of six different brands of wafer-type biscuits available in the local market, comparing the sensory and instrumental results.

2 MATERIALS AND METHODS

Wafer-type biscuits were purchased at a local market, in Rio Verde, Goiás (GO). This project was previously approved by the Research Ethics Committee under opinion 2,378,066. All participants signed the Informed Consent.

The triangular test was used for the pre-selection of the judges using two brands of wafer-type biscuits, arranged in trays, with two samples being the same, and one different (Figure 1). The testing cabins were illuminated with red lighting to camouflage the possible perception of differences upon initial contact with the samples.

After selection, texture training was carried out, where descriptions were used for the attributes: hardness (sausage, olive, raw carrot, and hard candy); chewiness (sausage, gummy candy, jelly candy, and caramel); fracturability (corn cake, meringue, cream cracker, and toast); and adhesiveness (margarine, cream cheese, marshmallow, and peanut butter) (Dutcosky, 2019) (Figure 2). These foods were arranged in trays and ordered from least to most intense. After the judges tasted each items three times at different moments, a test was carried out to evaluate the efficiency of the training performed.

After the training and selection of the judges, descriptive sensorial analysis of the texture profile was carried out using six brands of chocolate-flavored wafer-type biscuits, referred to as samples A, B, C, D, E, and F. The judges evaluated each sample individually taking into account considering the attributes they had been trained on and describing the sensations perceived when consuming the wafer-type biscuits. The data obtained by the test were discussed and organized, detailing the evaluators' observations for each sample.

Instrumental texture analysis was carried out using a compression test to evaluate the hardness of the samples using a CT3 texturometer (Brookfield Engineering Laboratories, INC. Middleboro, Massachusetts, USA) with a probe (TA4/100) and rectangular base (TA-BT-KIT). The compression test was conducted at a speed of 2.0 mm/s for the pre-test, 5.0 mm/s for the test, 10.0 mm/s for the post-test, with a deformation of 5.0%, and 5 repetitions were carried out on wafer-type biscuits measuring 90 x 20 x 10 mm. The Texture Profile Analysis (TPA) approach used a speed of 1.0 mm/s for the pre-test and test, 10.0 mm/s for the post-test, and tension of 60%, with samples measuring 20 x 20 x 10 mm. In the shear test, the standard blade set (HDP/BS, Brookfield Engineering Laboratories, 107 INC. Middleboro, MA, USA) was used. Both were performed in a TA-XT Plus texturometer (Stable Micro Systems, Surrey, UK). Data were submitted to statistical analysis using the Sisvar 5.6 software (Ferreira, 2011), employing ANOVA and Tukey test ($p \leq 0.05$), and presented as mean ± standard deviation.

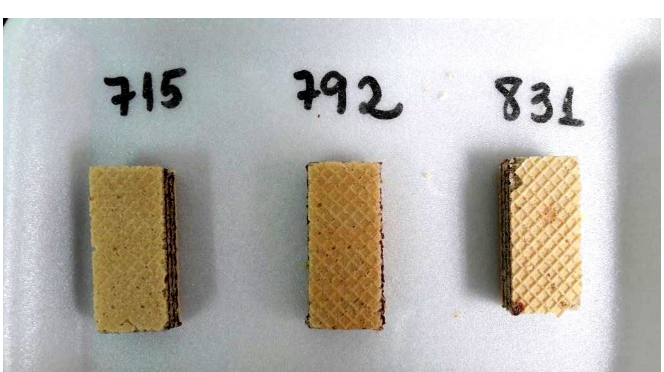

Figure 1. Wafer-type biscuits were arranged on the tray to perform the triangular test by the judges.

3 RESULTS AND DISCUSSION

3.1 Recruitment and pre-selection of evaluators

Evaluators were pre-selected via a triangular test so that the difference could be observed between two samples of chocolate-flavored wafer-type biscuits (Figure 1). Out of 30 judges, 73% correctly identified the different sample among the three served, while 26% answered incorrectly. Through the Spearman coefficient, it was possible to define the training efficiency for each evaluator and attribute, with a critical correlation value of 0.886 and a significance level of 5%. With this, 22 evaluators proceeded to the next stage, which consisted of training for texture profiling.

3.2 Training and selection of evaluators

The training, as outlined in the materials and methods section (Figure 2), was conducted with 12 judges. Two judges were excluded for not achieving a percentage of correct answers greater than or equal to 80% in the efficiency test, while 10 judges advanced to the descriptive stage.

Figure 2. Trays containing the wafer-type biscuits to carry out training for texture profile.

3.3 Texture profile definition

The final step was performed using 9 previously trained judges. They were asked to describe, according to the training performed, the characteristics of the samples perceived initially (first bite), during chewing, and after chewing (residual flavor). For this, samples of individual wafer-type biscuits were served, accompanied by a form for description.

For the brand A wafer-type biscuits, all the judges indicated the fractureability attribute as the most important during the first bite, describing it from weak to medium difficult to break. During chewing, the judges observed easy disintegration, not requiring many bites, reporting a slight stickiness and little aftertaste at the end of chewing.

For the brand B wafer-type biscuits, in the initial perception of the bite, the judges observed a fractureability ranging from medium to intense, and during average hardness during chewing, with a need for more time in the mouth and weak adhesion, leaving no aftertaste.

Regarding the brand C wafer-type biscuits, the judges initially reported medium to high fractureability, followed by easy chewing with intense adhesiveness, resulting in a lingering aftertaste.

The evaluation of the wafer-type biscuit of brand D was divergent, with some judges perceiving intense fractureability and others perceiving it as weak. Most of the judges reported average fractureability, easy chewing, intense stickiness, and with an intermediate aftertaste.

For the E brand wafer-type biscuits, the judges reported weak to moderate first perception of breakability, chewiness, and hardness, with intense stickiness noted at the end.

3.4 Instrumental texture analysis

Table 1 shows the instrumental results obtained in the compression test for the hardness parameter.

The compression test, which simulates the force exerted by molar teeth during mastication, showed that brands B, E, and F did not differ from each other, obtaining lower values and, consequently, lower hardness than the other brands. Brands A and D also did not differ from each other, maintaining intermediate hardness, and, finally, brand C presented the highest value, being the hardest sample.

There was a positive correlation between the instrumental analysis and the sensory profile for brand E of the wafer-type biscuit and the judges considered the hardness to range from weak to moderate. On the other hand, there was divergence in the responses for brand F, indicating higher intensity of this parameter, while brand B was considered median by the judges.

Brands A and D, statistically characterized with median hardness, were described by evaluators ranging from weak to intense, but most of them considered it as intermediate, which is in line with what was obtained instrumentally.

Brand C presented overload during the compression test, where it was not possible to deform the sample within the defined percentage (5%). In this sample, the judges considered it as intermediate, while in the instrumental evaluation, it showed greater hardness. A difference between this brand with others is the absence of lactose in the list of ingredients.

Instrumental hardness ranged from 73.42 to 348.07 N for tapioca and rice flour biscuits (Montes et al., 2015) and 27.36–30.29 N for those enriched with coconut flour (Queiroz et al., 2017).

Table 2 presents the instrumental results obtained for TPA in grams and for shear in Newtons.

The TPA approach to the changes that occur during mastication through the double compression performed by the equipment is similar to the compression test. In this test, brand C was considered the most intense in hardness, and brand E was the least intense in this parameter, consistente with the first instrumental test. Moreover, no significant differences were found between samples C and D, between B, C, and F, and between A and C, demonstrating that this pattern was consistent with the classification varying from weak, intermediate, to intense in the sensory analysis.

The shear test evaluated crispness through the rupture of the sample by the equipment, correlating with the fractureability reported by the judges in the sensory analysis. Crispness is an attribute highly correlated with characteristics perceptible to the human senses, such as hardness, breaking ability, sound when breaking, and pressure during the first bite (Kohyama, 2020). There was no significant difference between the crispness of the brands A, B, and E, which obtained higher values of force to break the wafer biscuit, and in general, the judges defined the fractureability parameter for these brands as intermediate. Brands A, C, D, E, and F showed no significant difference, but with lower values in this test.

Table 1. Wafer-type biscuit hardness evaluated by texturometer equipament.

Wafer-type biscuit brand	Hardness (N)
A	211.06 ± 1.72 b
B	169.61 ± 9.08 c
C	296.42 ± 2.68 a
D	220.41 ± 6.82 b
E	153.39 ± 4.54 c
F	158.06 ± 12.37 c

Means ± Standard Deviation followed by the same letters do not differ from each other by the Tukey test ($p \leq 0.05$).

Table 2. Results for Texture Profile Analysis (g) and shear (N) of wafer-type biscuits

Wafer-type biscuits	TPA (g)	Shear (N)
A	15,514.27 ± 1,406.97 c	20.98 ± 2.30 ab
B	21,854.48 ± 3,589.84 b	24.45 ± 3.60 a
C	23,524 ± 2,929.75 ab	19.62 ± 1.99 b
D	26,895.23 ± 2,346.12 a	19.95 ± 2.84 b
E	16,366.52 ± 1,462.49 c	22.58 ± 5.08 ab
F	20,649.94 ± 3,209.45 b	18.78 ± 4.04 b

TPA: Texture Profile Analysis; N: Newtons; Means ± Standard Deviation followed by the same letters do not differ from each other by the Tukey test ($p \leq 0.05$).

4 CONCLUSION

Differences in perception by evaluators lead to greater variation in values, contrasting with the consistency seenin instrumental evaluation. However, it was possible to observe that in the definition of the texture profile (sensory analysis), hardness and fractureability are the most striking parameters when evaluating wafer biscuits, and the variety of brands is a differential for the availability and ease of access to this type of food, regardless of consumers' social class.

REFERENCES

Davidov-Pardo, G., Moreno, M., Arozarena, I., Marín-Arroyo, M., Bleibaum, R., & Bruhn, C. (2012). Sensory and consumer perception of the addition of grape seed extracts in cookies. *Journal of Food Science, 77*(12), S430-S438. https://doi.org/10.1111/j.1750-3841.2012.02991.x

Devezeaux De Lavergne, M., Young, A. K., Engmann, J., & Hartmann, C. (2021). Food Oral Processing—An Industry Perspective. *Frontiers in Nutrition*, *8*, 634410. https://doi.org/10.3389%2Ffnut.2021.634410

Di Cairano, M., Caruso, M. C., Galgano, F., Favati, F., Ekere, N., & Tchuenbou-Magaia, F. (2021). Effect of sucrose replacement and resistant starch addition on textural properties of gluten-free doughs and biscuits. *European Food Research and Technology*, *247*(3), 707-718. https://doi.org/10.1007/s00217-020-03659-w

Dourado Gomes Machado, T. A., Pacheco, M. T. B., do Egypto Queiroga, R. C. R., Cavalcante, L. M., Bezerril, F. F., Ormenese, R. C. S. C., Garcia, A. O., Nabeshima, E. H., Pintado, M. M. E., & de Oliveira, M. E. G. (2021). Nutritional, physicochemical and sensorial acceptance of functional cookies enriched with xiquexique (Pilosocereus gounellei) flour. *PLoS One*, *16*(8), e0255287. https://doi.org/10.1371/journal.pone.0255287

Dutcosky, S. (2019). *Análise sensorial de alimentos*. PUCPress.

Egea, M. B., De Sousa, T. L., Dos Santos, D. C., De Oliveira Filho, J. G., Guimarães, R. M., Yoshiara, L. Y., & Lemes, A. C. (2023). Application of Soy, Corn, and Bean By-products in the Gluten-free Baking Process: A Review. *Food and Bioprocess Technology*, *16*(7), 1429-1450. https://doi.org/10.1007/s11947-022-02975-1

Ferreira, D. F. (2011). Sisvar: a computer statistical analysis system. *Ciência e Agrotecnologia*, *35*(6), 1039-1042. https://doi.org/10.1590/S1413-70542011000600001

Gámbaro, A., Roascio, A., Hodos, N., Migues, I., Lado, J., Heinzen, H., & Rivas, F. (2021). The impact of sensory attributes of mandarins on consumer perception and preferences. *Journal of Agriculture and Food Research*, *6*, 100196. https://doi.org/10.1016/j.jafr.2021.100196

Goswami, M., Sharma, B. D., Mendiratta, S. K., & Pathak, V. (2021). Quality improvement of refined wheat flour cookies with incorporation of functional ingredients. *Journal of Food Processing and Preservation*, *45*(4), e14945. https://doi.org/10.1111/jfpp.14945

Grossmann, L., Kinchla, A. J., Nolden, A., & McClements, D. J. (2021). Standardized methods for testing the quality attributes of plant-based foods: Milk and cream alternatives. *Comprehensive Reviews in Food Science and Food Safety*, *20*(2), 2206-2233. https://doi.org/10.1111/1541-4337.12718

International Organization for Standardization (ISO) (2008). *5492. Terms relating to sensory analysis*. International Organization for Standardization.

Kohyama, K. (2020). Food Texture–sensory evaluation and instrumental measurement. *Textural Characteristics of World Foods*, 1-13. https://doi.org/10.1002/9781119430902.ch1

Liu, J., Cattaneo, C., Papavasileiou, M., Methven, L., & Bredie, W. L. (2022). A review on oral tactile acuity: measurement, influencing factors and its relation to food perception and preference. *Food Quality and Preference*, *100*, 104624. https://doi.org/10.1016/j.foodqual.2022.104624

Mihafu, F., Issa, J., & Kamiyango, M. (2020). Implication of Sensory Evaluation and Quality Assessment in Food Product Development: A Review. *Current Research in Nutrition and Food Science Journal*, *8*(3), 690-702. https://doi.org/10.12944/CRNFSJ.8.3.03

Montes, S. S., Rodrigues, L. M., Cardoso, R. C. V., Camilloto, G. P., & Cruz, R. S. (2015). Biscoito de farinhas de tapioca e de arroz: propriedades tecnológicas, nutricionais e sensoriais. *Ciência e Agrotecnologia*, *39*(5), 514-522. https://doi.org/10.1590/S1413-70542015000500010

Queiroz, A. M., Rocha, R. F. J., Garruti, D. S., Valença da Silva, A. P., & Araújo, Í. M. S. (2017). Elaboração e caracterização de cookies sem glúten enriquecidos com farinha de coco: uma alternativa para celíacos. *Brazilian Journal of Food Technology*, *20*, e2016097. https://doi.org/10.1590/1981-6723.9716

Savouré, T., Dornier, M., Maraval, I., & Collignan, A. (2021). Sensory quantitative descriptive analysis of African slimy okra (Abelmoschus esculentus) preparations and its correlation with instrumental parameters. *Journal of Texture Studies*, *52*(3), 314-333. https://doi.org/10.1111/jtxs.12583

Šmídová, Z., & Rysová, J. (2022). Gluten-free bread and bakery products technology. *Foods*, *11*(3), 480. https://doi.org/10.3390/foods11030480

Świąder, K., & Marczewska, M. (2021). Trends of using sensory evaluation in new product development in the food industry in countries that belong to the EIT regional innovation scheme. *Foods*, *10*(2), 446. https://doi.org/10.3390/foods10020446