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Sensory descriptive analysis and hedonic consumer test for Galician type breads

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A R T I C L E I N F O

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A B S T R A C T

Bread consumption has declined in recent years due to the loss of its sensory quality. To identify the key sensory attributes for the consumer, in this study will provide to the bakery industry with a powerful tool to design products adapted to the consumer preferences will be provided to the bakery industry.

For identifying the key attributes 7 Galician breads were evaluated by a trained panel using 22 attributes using the Quantitative Descriptive Analysis. In addition, a sensory acceptance test carried out by 97 consumers provided hedonic evaluations.

The results of the joint analysis (trained panel and consumers) demonstrated that the loaves with the moistest bread crumb, with a predominance of large cells, and an alveolation with non-uniform distribution were the ones that presented the greatest acceptance.

The use of an artisanal production process (sourdough and long fermentation time) and the incorporation into the recipe of indigenous flour (around 40%) improved the acceptance of the Galician bread.

1. Introduction

As a foodstuff, bread is popular all over the world because of its price, availability, nutritional quality, sensory and textural properties (Patel, Waniska, & Seetharaman, 2005; Battochio et al., 2006; Lambert et al., 2009). Consumers, apart the sensory characteristics, also choose functional and healthy bakery products, apart the sensory characteristics (Jerzy, Jezewska-zychowicz, & Szlachciuk, 2019). Bread is also an important nutrient provider (Dewettinck et al., 2008).

The many bread products and the production techniques share one common goal: to transform cereal flours into attractive, palatable, and digestible food (Chavan & Chavan, 2011).

Despite of the importance role of the bread in the diet, the bread intake in Spain has declined in recent decades. This negative trend is partly associated with the industrialization of the baking process that has resulted in a detriment of product sensory quality and with the myth that carbohydrates must be eliminated from the diet because they make you fat (Loria-Kohen et al., 2011). Despite the drop in bread consumption, the data indicated an intake of 43.86 kg/per capita yearly in Galicia well above the nation average, which stands at 32.54 kg/per capita yearly (MAPA, 2020). It is probably due to the fact that artisanal production is still largely maintained in this region that apports a differentiated quality.

Due to its popularity and regional differences, many breads are covered by different quality designations that guarantee the exclusivity and the differentiated quality of a product, among them the protected geographical indication (PGI) Galician bread (European Union, 2019). The Galician bread is characterized by a crusty crust and springy crumb. The crust hardness varies depending on the shape. The crumb presents abundant and irregular alveoli and an intense wheat flavour with a slightly acidic and very aromatic should be perceived. It is made with soft wheat flour (*Triticum aestivum, L.),* 25% of this wheat is indigenous wheat, grown in Galician region (NW-Spain) using native varieties and ecotypes. In the breadmaking is used a minimum quantity of sourdough of 15% of the weight of the flour used and high amounts of water as well as long fermentation and baking times.

The artisanal breadmaking is characterized by long fermentation time and sourdough use. It provides a greater variety of volatile

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compounds as compared to shorter or industrial methodologies (Van Kerrebroeck, Comasio, Harth, & De Vuyst, 2018). Sourdough also improves bread volume, crumb structure (Arendt, Ryan, & Dal Bello, 2007), nutritional value (Koistinen et al., 2018; Kopeć et al., 2014) and shelf life (Muhialdin, Hassan, & Sadon, 2011; Plessas et al., 2011).

Sensory quality can be evaluated through analytical methods (objective) and consumer hedonic studies (subjective) (Giménez et al., 2007).

The perception of freshness is a key factor in the consumer choice and acceptability of bread products. The perception of freshness is a complex process related with the perception of appearance, odour, taste and texture perception. The loss of bread freshness causes a decrease in sensory shelf life and is related to how the texture parameters evolve over time (Lassoued, Delarue, Launay, & Michon, 2008).

For the application of sensory analytical methods a trained sensory bread panel is required to be able to characterize the bread in a qualitative and a quantitative way and to establish the sensory profile (Kihlberg, Johansson, Kohler, & Risvik, 2004). Since its inception, the application of sensory analysis as a quantitative-descriptive measurement technique has been increasingly applied in food research, and bread is no exception. Sensory analysis has been applied to evaluate the influence of the ingredients, different conditions in the bread-making process or the shelf life of bread (Callejo, 2011; Heenan, Dufour, Hamid, Harvey, & Delahunty, 2008; Kihlberg et al., 2004; Perri et al., 2021; Silva et al., 2021).

Bread is the product resulting from the baking of a dough obtained by the mixture of flour and drinking water, with or without the addition of salt, fermented by baker's yeast or sourdough (BOE, 2019). Each ingredient has a key role in the bread-making process (Giannou, Kessoglou, & Tzia, 2003; Chavan & Chavan, 2011).

The water added to the flour during the kneading procedure affects the formation of the elastic gluten network, and therefore the texture of the dough (Dewettinck et al., 2008; Sievert, Hoseney, & Delcour, 2007).

The role of yeast is to metabolize fermentable sugars under anaerobic conditions which produces carbon dioxide (CO_2) that is retained and, in turn, responsible for the rising of the dough as well as for sucrose hydrolysis.

Apart from its main role in flavouring, sodium chloride also promotes the action of amylases, strengthens the gluten and modulates the fermentation. Furthermore, it enhances the crust color during baking and increases the water holding capacity (Bassett et al., 2014; Belz et al., 2017).

The aim of this study was to determine which sensory attributes influence the consumer acceptance of different Galician breads in the usual format that they are marketed and to relate them to the ingredients and manufacture process used.

2. Materials and methods

2.1. Wheat flour

Three types of wheat flour were used. The parameters measured by the alveograph test were P (tenacy) is related to the resistance of the dough to deformation; L (extensibility) is an indication of dough extensibility; W (baking strength) represents the energy required to expand the dough and is related to flour strength; P/L ratio represents the balance of the elastic and viscous components of the dough and G (Swelling index) is the square root of the volume of air required to rupture the dough. The values of the parameters indicated for each flour were: Castilla origin extra strong flour (P = 116 mm, L = 100 mm, G = 24.7, W = 406·10-4 J and P/L = 1.04), Castilla origin strong flour (P = 90 mm, L = 112 mm, G = 22.3, W = 350·10-4J and P/L = 0.90) and Galician indigenous wheat flour (P = 96 mm, L = 54 mm, G = 16.4, W = 175·10-4 J and P/L = 1.78).

2.2. Sample preparation

Seven bread samples (Fig. 1) were used for the sensory analysis which consisted of a descriptive sensory analysis and a consumer hedonic study. The breadmaking includes the selection and weighing of the ingredients (flour, sourdough, yeast, salt and water), kneading, resting (during which fermentation takes place) and baking. The weight of the pieces as they are marketed, dough recipes, fermentation and baking conditions for each sample were summarized in Table 1. No additives were added. The samples were prepared a few hours before their analysis and they were analysed by both judges and consumers once they reached room temperature.

2.3. Descriptive sensory analysis

Before they were included in the panel, potential members were first screening based on sensory acuity. Then, the selected judges were trained for sensory bread evaluation and they had to pass a validation process (Estévez-López, García-Gómez, Vázquez-Odériz, Ferreiro-Muñoz, & Romero-Rodríguez, 2020). The resulting panel was formed by 12 trained judges, which met once a week.

Assessors were trained for six months and a total of 21 descriptive terms were defined with their respective references. Each assessor evaluated the intensity of the terms for each sample using an unstructured 10 cm-line scale ranking according to the references (Table 2) previously determined for all attributes (Estévez-López, García-Gómez, Vázquez-Odériz, Ferreiro, & Romero-Rodríguez, 2020).

Sensory tests were carried out in a standard tasting room (ISO 8589, 2007) equipped with individual taste booths separated by screens that were sufficiently high and wide to isolate the different judges. Samples were served at room temperature (about 20 °C) in black dishes.

Each sample was labelled with random 3-digit codes and the evaluations were performed in accordance with a Williams design. The Williams design is a special case of the cross-over and Latin square designs. Water was provided to clear the judges' palates between sample evaluations.

Visual attributes were evaluated from a piece of bread cut in half. For texture, odour, taste and aroma attributes, the judges received a piece of bread of each type with dimensions measuring 10 × 3 cm (including crumb and crust). Reference standards were provided at each session, and assessors were required to refer to these prior to each evaluation. The samples were presented in a sequential monadic way with 2 repetitions per sample. The duration of each session ranged 1–1.5 h.

Two replicates in different sessions were performed.

2.4. Hedonic consumer test

The acceptance test was conducted with 97 consumers (76.3% females and 23.7% males). Respondents aged between 18 and 39 years old (70.1%), 40–59 years old (17.5%) and over 60 years old (12.4%). The criterion of selection for consumers was that they be habitual consumers of bread. The consumer evaluation took place in a sensory laboratory in individual panel booths using a hedonic taste sheet. The bread samples were evaluated at room temperature. A sample consisted of a piece of bread of each type, with dimensions measuring 10 × 3 cm (including crumb and crust) presented in a disposable dish and labelled with a three-digit code. The attributes: visual appearance (whole and cut piece), texture, odour, taste, freshness and overall acceptance were evaluated on a structured 9-point hedonic scale (1-dislike extremely, 2-dislike very much, 3-dislike, 4-dislike slightly, 5-neither like nor dislike, 6-like slightly, 7-like, 8-like very much and 9-like extremely). Consumers were instructed to clean their mouths with water between samples to cleanse their palates. All samples were presented in the sequential monadic test using complete block design. No information about the samples was given to the consumers and they did not receive any monetary incentive for their participation to prevent bias.

Fig. 1. Breads analysed in the study.

Table 1
Dough recipes for the breads and baking processes.

Sample and weight	Flour type	Yeast	Fermentation			Baked	
			Time (min)	N° fermentations	Tª (°C)	HR (%)	Time (min)
A (1 kg)	40% indigenous wheat flour (origin: Galicia) 60% wheat extra strong flour (origin: Castilla)	0.5	120 + 30	2	25 ± 1	77.5 ± 2.5	75
B (1 kg)	40% indigenous wheat flour (origin: Galicia) 60% wheat extra strong flour (origin: Castilla)	0.5	120 + 30	2	25 ± 1	77.5 ± 2.5	53
C (1 kg)	40% indigenous wheat flour (origin: Galicia) 60% wheat extra strong flour (origin: Castilla)	0.5	120 + 30	2	25 ± 1	77.5 ± 2.5	75
D (400 g)	60% indigenous wheat flour (origin: Galicia) 40% wheat extra strong flour (origin: Castilla)	0.3	120 + 120+30	3	25 ± 1*	77.5 ± 2.5	60
E (250 g)	40% indigenous wheat flour (origin: Galicia) 60% wheat extra strong flour (origin: Castilla)	0.5	120 + 30	2	25 ± 1	77.5 ± 2.5	37
F (400 g)	40% indigenous wheat flour (origin: Galicia) 60% wheat extra strong flour (origin: Castilla)	0.5	120 + 30	2	25 ± 1	77.5 ± 2.5	40
G (250 g)	20% indigenous wheat flour (origin: Galicia) 80% wheat extra strong flour and wheat strong flour (origin: Castilla)	0.5	140 + 30	2	26 ± 1	70 ± 1	28

Notes. Sourdought = 32 L/100 kg of flour; ClNa = 1.90% and baking Tª = 220±5 °C. In bread D: 2nd fermentation (20 h/4 °C).

2.5. Statistical analysis

Principal Component Analysis (PCA) was performed in order to summarize the information in the descriptive analysis and to visually highlight the similarities and differences between sensory profiles.

A nonparametric Friedman test was performed in order to study possible differences in consumer acceptance scores between bread samples. A nonparametric analogue to Fisher's LSD for rank sums was also applied to study significant pairwise differences.

Spearman's rank correlation coefficient was applied to find out which hedonic attributes showed a high correlation with the overall acceptance.

The Chi-Square test of Independence was applied to study the association between hedonic scores and sociodemographic variables (gender and age group). Fisher's exact test was applied when there were more than 20% expected cell counts below 5.

Multiple Factor Analysis (MFA) was performed in order to relate the consumers' acceptance in hedonic terms with the descriptive sensory profile.

Statistical analyses were performed using IBM SPSS Statistics 24 and R (R Core Team, 2020). R packages FactoMineR (Lê & Worch, 2015) and agricolae (De Mendiburu, 2017, pp. 2–8).

3. Results and discussion

3.1. Descriptive sensory analysis

PCA was used to explain differences between the samples from a

Table 2
Definition, scale and references for the quantitative sensory descriptors (Estévez-López et al., 2020).

Descriptor	Definition	Scale and references	
Appearance			
Crust color	Sensation produced on crust color, resulting from stimulation of the retina by light waves in the visible region of the spectrum.	Pale brown	Dark brown
Crumb color	Sensation produced on crumb color, resulting from stimulation of the retina by light waves in the visible region of the spectrum.	White	Dark brown
Uniformity of cell distribution	Grade of uniformity on distribution cells	Not uniform	Uniform
Amount of large cells	Percentage of area occupied by large cells	0% of similar size or larger size than a lima bean	100% of similar size or larger size than a lima bean
Amount of medium cells	Percentage of area occupied by medium cells	0% of size between a lentil and a lima bean	100% of size between a lentil and a lima bean
Amount of small cells	Percentage of area occupied by small cells	0% of equal or smaller size than a lentil	100% of equal or smaller size than a lentil
Flour residue (crust)	Amount of flour on the crust	Absence	Fully covered
Odour			
Fermented dough odour	Intensity of the stimulus associated with yeast odour perceived when the bread is placed in front of the nose	Absence	Commercial yeast
Hand texture			
Moistness (crumb)	Surface property relating to the perception of the amount water absorbed or released by the product when roll our finger along the crumb while applying slight pressure.	"Soletilla" sponge cake	No curd "Manchego" cheese
Compactness (crumb)	Degree of perceived compactness measuring the required force to sink the index finger on the crumb with the sample resting on a firm surface.	Sponge (5)	
Springiness (crumb)	Degree of springiness in crumb by pressing between fingers and measuring the recovery time	>12 s.	2 s.
Mouth texture			
Crispiness (crust)	Grade of perceived crispiness	"Soletilla" sponge cake	Puff pastry cookies
Hardness (crust)	Force required to eliminate the resistance and bite completely through sample placed between the molars on the first bite	"Campurrianas" cookies (5)	
Softness (crumb)	Degree of softness of the crumb rubbing between the tongue and the palate	Biscuits type "Lady finger"	Marshmallows
Adhesiveness	Force required to remove sample completely from the palate using the tongue	Biscuits type "Lady finger"	Melted cheese type tranchettes
Chewiness	Mechanical textural property relating to the number of chews necessary to bring the product to the state necessary for swallowing	10 chews	≥40 chews
Taste and aroma			
Sour taste	Basic taste similar to that of diluted aqueous solutions of citric acid	Absence	0.20 g/L
Salty taste	Basic taste similar to that of diluted aqueous solutions of sodium chloride	0.5 g/L (5)	
Bitter taste	Basic taste similar to that of diluted aqueous solutions of caffeine	0.1 g/L (5)	
Wheat aroma	Intensity of the olfato-gustatory sensation perceived during mastication associated with typical aroma of wheat	Absence	Dough make with wheat flour and water and cooked in microwave during 2 min–800 W
Persistency	Duration of the olfato-gustatory sensation perceived after the bolus leaves the mouth	<10 s.	≥60 s.

sensory descriptive point of view (Fig. 2).

Bread G was completely different from the rest of the loaves studied. This bread showed many small cells with uniform distribution; the bread crumb had a low level of moisture and a scarce persistency. The differences observed in this bread could be due to the smaller size and the narrow and elongated shape that can favour the evaporation of water. Another cause could be the different fermentation conditions since the temperature and relative humidity were lower than for the other loaves (Table 1). The presence of uniform cell distribution with a predominance of small cells could be related to the shape of the loaves; bread G was bar shaped, thus, some degassing could occur. The alveolation could also be related to the degree of dough hydration, since when the hydration is low, less air is trapped in the dough, and/or it could be due to a more mechanical elaboration process, in which the temperature and humidity conditions during fermentation were different from the rest of the loaves (Table 1).

Loaf D was different from the other loaves in terms of crust and crumb colour because a darker crumb and crust were observed. This is justified by carrying a greater quantity of native Galician flour, which is

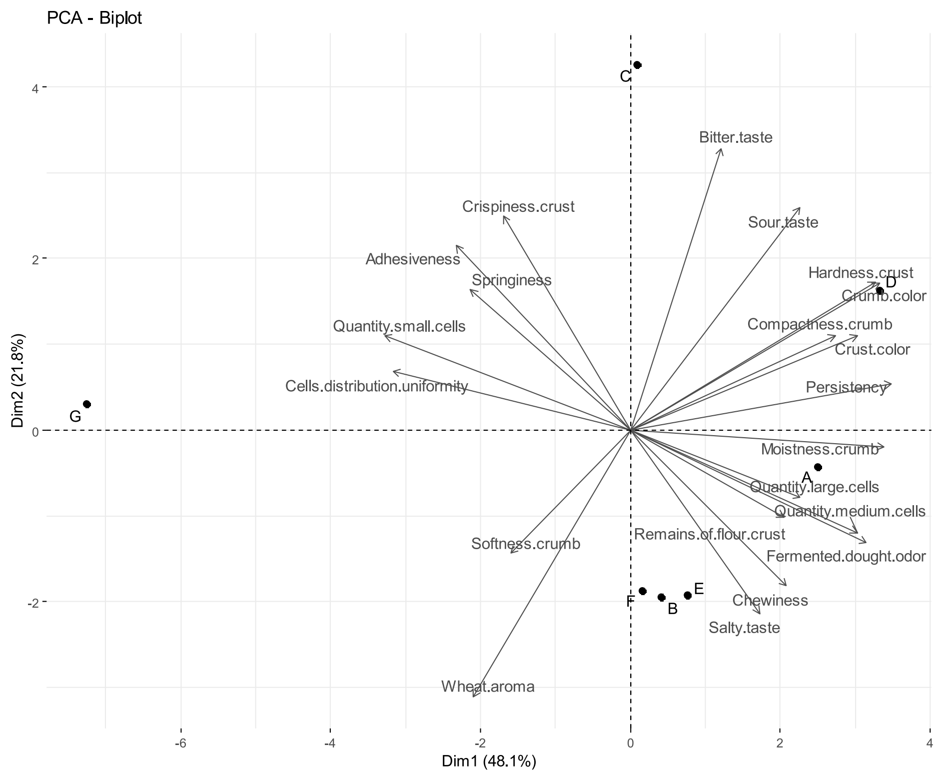

Fig. 2. Principal component analysis (PCA) performed with descriptive sensory data.

darker than Castilla one. Loaves D and A presented sensory characteristics opposite to those of bread G, since they presented many large cells which were not uniformly distributed. There was a higher level of bread crumb moisture, the crumb was more compact, and the crust was harder than the other loaves. In addition, the sourness and persistence in the mouth was also higher than in the others. None of these characteristics was elevated for Bread G. The sourness, mainly in bread D, can be justified by a greater proportion of sourdough:yeast since only 0.3 kg of yeast was added instead of 0.5 kg of yeast per 100 kg of flour as occurred in the other loaves. Furthermore, bread D was fermented for more than 20 h since it was kneaded until it was baked.

Retrogradation in breads has been related to a shorter baking times, observing a lower firmness and resistance of the crumb (Bosmans, Lagrain, Fierens, & Delcour, 2013). The loaf G showed a lower compactness of the crumb than the loaves A and D, possibly due to the lower retrogradation caused by a shorter baking time (Table 1).

Regarding the sour taste, all the breads were made with sourdough. Sourdough bread is prepared from a mixture of flour and water that is fermented with lactic acid bacteria, mainly hetero-fermentative strains responsible for the lactic and acetic acid production in the sourdough which produce a pleasant sour taste in the final product (Chavan & Chavan, 2011). More particularly, bread D was the sourest, probably because the sourdough:yeast ratio was higher than in the other loaves analysed, and additionally because three-step fermentation was used to make it. Bread C, in contrast to breads B, E and F, showed the highest scores for bitter taste, which may be due to the cuts made in the crust and a longer baking time, since these two factors promoted the formation of compounds responsible for the presence of a bitter taste.

Breads B, E and F were very similar to each other; the presence of a salty taste that was higher than in the other loaves was identified, even when the amount of salt added in the recipe was the same for the seven loaves analysed. This difference was probably due to a larger surface area which resulted in greater water evaporation and a consequent increase in salt concentration, mainly in sample B, which had the largest surface area. Low scores were also observed for bitter taste and crust crispiness. The lowest scores regarding crust crispiness might be due to the use of a shorter baking time.

3.2. Hedonic consumer test

Consumers were asked about the acceptance of the seven breads.

Bread G obtained the lowest scores in all the hedonic attributes, except in the whole appearance attribute (Fig. 3), with a median of 6 points (“like slightly”). Statistically significant differences were observed between the samples in all the descriptors. The lower acceptance of bread G was most likely due to the high proportion of Castilla flour and a more mechanized breadmaking compared with the other loaves, negatively affecting its acceptance.

Samples D and F scored slightly above G yet were among the lowest scores in all the hedonic attributes. On the other hand, samples A, B, C and E received the highest scores, and sample E was singled out for best acceptance of appearance and best acceptance of odour.

Spearman’s rank correlation coefficient allowed for the identification of the hedonic attribute that correlated the most to overall acceptance. Thus, for bread B and F, the most correlated attributes were texture ($r = 0.702$, $p < 0.01$) and freshness ($r = 0.802$, $p < 0.01$) respectively. Meanwhile, taste was the most correlated attribute for the overall acceptance of breads A ($r = 0.684$, $p < 0.01$), C ($r = 0.682$, $p < 0.01$), D ($r = 0.778$, $p < 0.01$), E ($r = 0.710$, $p < 0.01$) and G ($r = 0.862$, $p < 0.01$). Despite these findings regarding taste, both texture and freshness also showed significant correlations with overall acceptance.

Texture is an indicator of bread freshness, and both are determinant attributes for bread acceptability (Chavan & Jana, 2008). However, the bread taste was less relevant when compared to other foods (Liu & Scanlon, 2004). In addition, it is necessary to take into consideration that the bread freshness is maintained for a short period of time (Angioloni & Collar, 2009) drastically reducing its shelf life. The loaves analysed were made with sourdough. The addition of sourdough is associated with an improvement in the textural properties of the bread (Arendt et al., 2007). As a consequence, the acceptance of sourdough

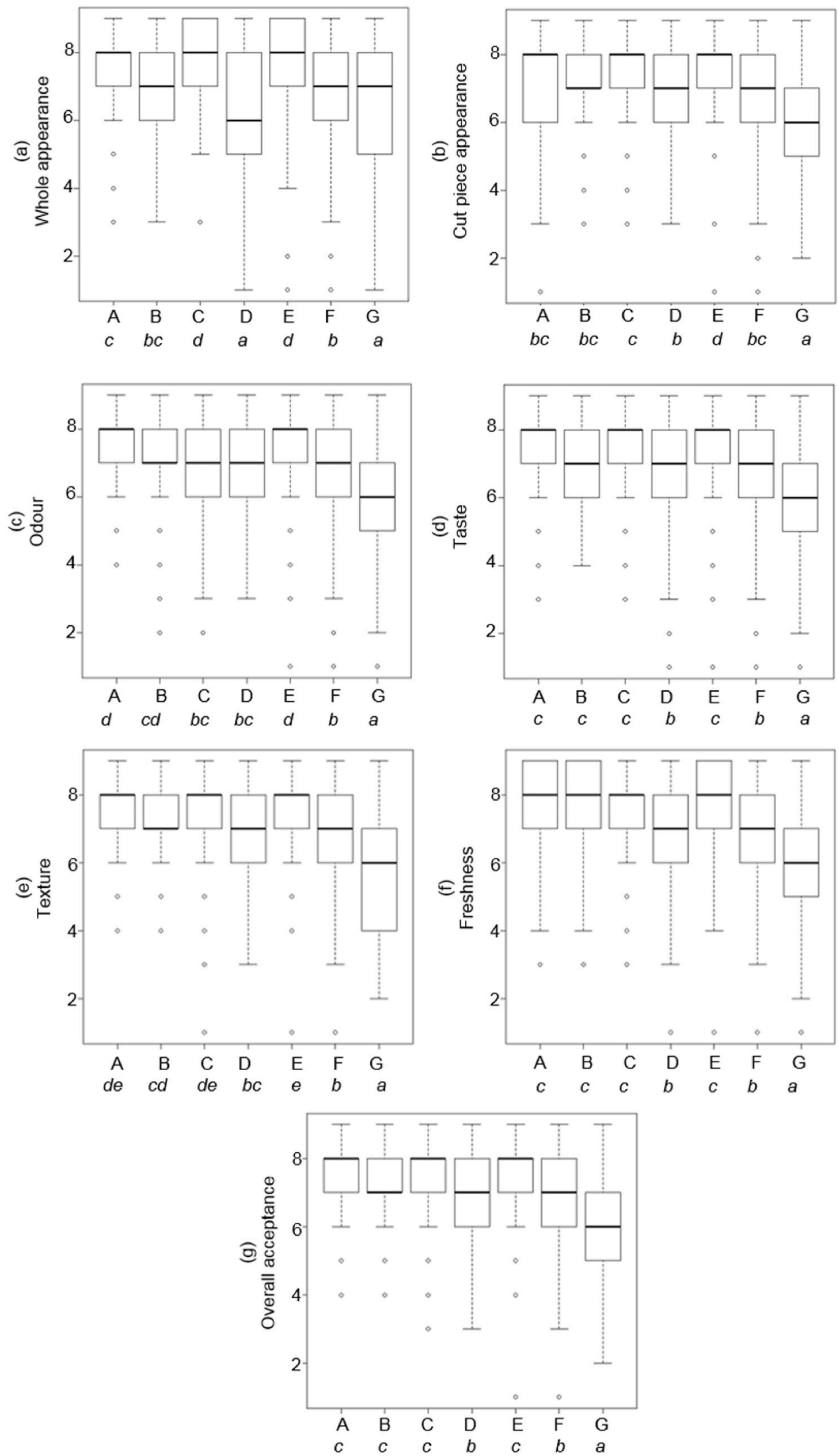

Fig. 3. Boxplot for the consumer acceptance test (a: whole appearance, b: cut piece appearance, c: odour, d: taste and aroma, e: texture, f: freshness and g: overall acceptance) using a structured nine-point hedonic scale. Different letters indicate significant statistical differences according to the nonparametric analog to Fisher's LSD for rank sums.

breads was high (Fig. 3). The bread with the lowest acceptance rate scored 6 points (Fig. 3g), which might be due to the fact that a lower proportion of Galician flour was added (Table 1).

Regarding the socio-demographic profile of the consumers, no statistically significant relationship was observed between the attributes or the overall acceptance with the gender or age group to which consumers belonged (the Chi-Square test of Independence and Fisher's exact test was not significant). Nonetheless, others researchers found a significant influence of gender and age on perceived freshness of different breads currently available in the New Zealand market (both specialty and commercial brands); it was the older consumers and females who assigned higher scores for freshness (Heenan, Dufour, Hamid, Harvey, & Delahunty, 2009).

3.3. A multidimensional approach to link consumer testing with descriptive measurements

The position of the samples most valued by consumers (A, B, C and E) and of the least valued ones (D and F) (Fig. 3) did not afford any relation between the descriptive analysis obtained by PCA and the consumers' acceptability. Therefore, the relationships between consumers scores (Consumer test) and trained panel evaluations (QDA) were analysed using multiple factor analysis. The relationship between the scores the consumers assigned to the hedonic descriptors of whole and cut slices of bread, odour, taste, texture, freshness and overall acceptance and the scores the trained panel assigned to the descriptors appears in the Multiple Factor Analysis (MFA) plot (Fig. 4).

It has been found that the acceptance of both the terms related to the appearance and the overall acceptance decreased when the cells were small and evenly distributed, which justifies, as indicated above, that G was the bread with the lowest acceptance rate. The higher acceptance rate of breads A, C and E both in terms of appearance and overall acceptance has been related to the presence of larger cells with an uneven distribution. These results coincide with the observations of other authors, which indicate that the structure of the bread crumb is defined in relation to the amount and size of the cells, as well as to how evenly the cells are distributed. They also conclude that the structure of the bread crumb has been related to the gluten content of the flour and the fermentation conditions (Callejo, 2011). Additionally, other researchers conclude that the characteristics of the bread crumb affect the visual perception, but also have a great influence on the properties of the texture and, therefore, on consumer acceptance (Lassoued et al., 2008).

The trained panel observed the crust of bread D to be darker than the other loaves. This fact might help to explain why consumers have shown an intermediate degree of acceptance for these loaves, since it was observed that the acceptance of the appearance, to a certain degree, suffered more with darker crumb and crust colours. Therefore, the loaves with intermediate crumb and crust colours are the ones with the highest acceptance (Fig. 4). Slightly darker crumb and crust colours correlated with higher appearance and overall acceptance scores, this correlation was not as strong as in the case of cell size and distribution.

This colour effect has also been confirmed by other researchers, who observed that the acceptance of bread was affected by colour (Bakke & Vickers, 2011).

Regarding texture and freshness, the strong correlation of these attributes with overall acceptance has been confirmed. When the relationship between these hedonic attributes and the texture descriptors evaluated by the trained panel was studied, it was observed that the descriptive attribute of texture that most affected the acceptance of the bread was how moist the bread crumb was. Breads E, A, B and C were the most well accepted in terms of texture, freshness and overall acceptance. A negative influence of crust crispiness on acceptance was observed, where bread G showed the lowest acceptance rate. Therefore, the loaves that presented a higher level of moisture in the bread crumb and a crust with a certain degree of hardness but that was not excessively crispy was the most well accepted.

Moistness was also identified as an attribute with great influence in other bread varieties, where respondents showed less intention to purchase breads which had a moisture content below what they considered to be just right (Charoenthaikij et al., 2010). The relationship between moistness and perception of freshness was confirmed in a study with consumers of bread in which freshness was associated with a moist texture (Heenan et al., 2009).

Finally, the analysis of the odour, taste and aroma descriptors showed that the loaves which had exhibited a higher intensity of fermented dough odour, a certain sour taste and high persistency were the ones most accepted by consumers.

Bread G was penalized in terms of acceptance due to the low scores from the descriptive point of view that it received for fermented dough odour, sour taste, salty taste and persistency.

Despite the results obtained in this study, other researchers identified bitterness to be a sensory barrier for whole wheat bread acceptance (Bakke & Vickers, 2011). In other studies, consumers were not able to appreciate differences between breads in attributes such as sour or salty taste (Heiniö, 2014).

4. Conclusions

Galician bread acceptance is related with the level of moisture in the bread crumb, which in turn is associated to freshness. Cell size and the

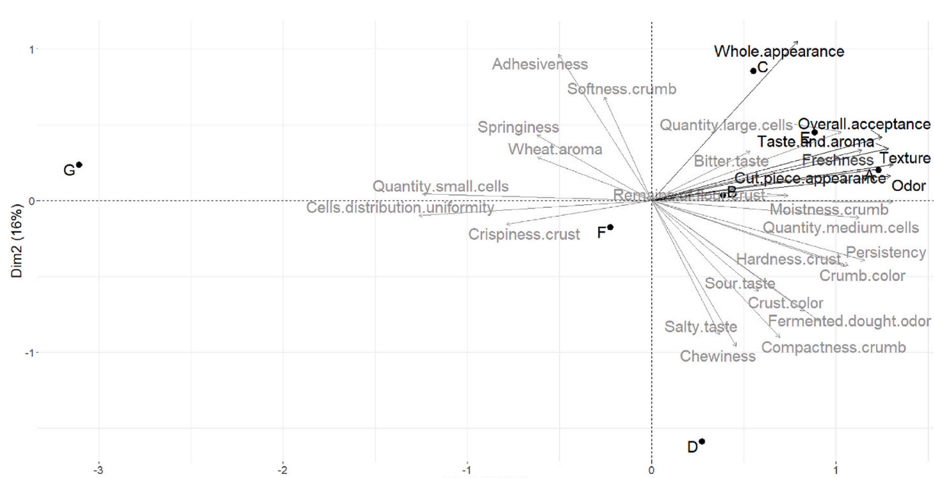

Fig. 4. Multiple factor analysis (MFA) biplot for mixing scores obtained from Quantitative Descriptive Analysis (grey labels) and consumer acceptance test (bold labels) for samples of bread A, B, C, D, E, F, G.

uniformity of cell distribution are also related with acceptance, since they affect visual perception and textural properties. The loaves that show a higher level of bread crumb moisture, and large, unevenly distributed cells are the ones which are awarded greater consumer acceptance.

The use of a higher proportion of Castilla flour and a greater mechanization of the breadmaking negatively affect consumer acceptance from a sensory point of view.

Therefore, the joint analysis of the evaluation with trained tasters (objective) and consumers (hedonic) is an effective tool to determine the key product attributes for the consumer acceptance. Knowing these key attributes allows the industry to minimize the risk of failure when releasing a new product to the market and/or to make more accurate reformulations, which leads to cost savings.

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Conflict interest form

I am **M[a] ÁNGELES ROMERO RODRÍGUEZ**, co-author of the article "Sensory Descriptive Analysis and Hedonic Consumer Test for Galician Type Breads" signed by Belén García-Gómez, Nerea Fernández-Canto, M[a] Lourdes Vázquez-Odériz, Maruxa Quiroga-García, Nieves Muñoz-Ferreiro and M[a] Ángeles Romero-Rodríguez.

I declare that there are no potential conflicts of interest relating to the Contribution reported by the authors.

I am authorized to sign on behalf of the other authors.

CRediT authorship contribution statement

Belén García-Gómez: Methodology, Investigation, Formal analysis, Writing – original draft. **Nerea Fernández-Canto:** Investigation. **Ma Lourdes Vázquez-Odériz:** Conceptualization, Writing – review & editing. **Maruxa Quiroga-García:** Conceptualization, Methodology, Formal analysis. **Nieves Muñoz-Ferreiro:** Data curation, Formal analysis. **Ma Ángeles Romero-Rodríguez:** Conceptualization, Investigation, Resources, Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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