1 **DOES CONSUMER LIKING FIT THE SENSORY QUALITY ASSESSED BY TRAINED**

2 **PANELISTS IN TRADITIONAL FOOD PRODUCTS? A STUDY ON PDO IDIAZABAL**

3 **CHEESE**

4 **Short running title: LIKING AND SENSORY QUALITY IN TRADITIONAL FOODS**

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Abstract

The aim of this work was to study the degree of agreement between consumer liking and the sensory quality scored by the trained panel in charge of the quality control of a traditional product (PDO Idiazabal cheese). Nine cheeses of different qualities were evaluated by eight trained assessors and by 212 consumers from Vitoria-Gasteiz (Basque Country). Cheese samples were clearly different regarding overall sensory quality (OSQ) assessed by the trained panel. Regarding consumers, five groups with different correlation levels with OSQ were identified: "sweet" and "toasty" were the main sensory drivers leading the liking of the consumers with a higher positive correlation, whereas some defective characteristics ("animal", "rancid" and "bitter") were the main drivers for consumers with higher negative correlation. These results suggest that it would be interesting for the Regulatory Council to strength the communicational strategies among consumers to be able to identify the typical and non-typical (mainly defects) characteristics of this traditional product, especially among those liking defective cheeses.

Practical Applications

This study gives information about the degree of agreement concerning the sensory quality of a traditional product reached by a trained panel and by consumers´ preferences.

The research includes information regarding the sensory characteristics which drive liking among different groups of consumers. These results are of interest for the Regulatory Council of this product to define its marketing polices and consumer-oriented education activities in order to provide information about the specific sensory characteristics of the product. Moreover, it may be interesting for PDO Regulatory Councils and other producers of traditional products in order to be more aware about the possible agreement and/or disagreement between the sensory quality of the product and consumer preferences.

Keywords

PDO Idiazabal cheese; sensory quality control; trained panel; consumers´ liking; sensory drivers.

1. Introduction

The food industry usually focuses on consumer preferences when establishing sensory quality control programs (Muñoz 2002; Pecore and Kellen 2002). However, there are certain traditional food products certified with quality labels where consumers´ preferences should have less influence on the sensory quality definition than in the case of conventional foods (Ojeda et al., 2015). This is the case of the food products with PDO (EU 2012), which are expected to present some distinctive sensory characteristics linked to their origin, raw materials and traditional practices (Ballester *et al.* 2005). Taking into account that an important goal of a PDO is to offer high quality products, it is necessary to define and control objectively their sensory characteristics in order to guarantee their authenticity and those sensory characteristics that differentiate them from similar commercial products (Bertozzi and Panari 1993). As a basis for the certification of the product, sensory quality control of PDO products requires both the development of a specific evaluation method as well as a trained panel to not only guarantee the absence of defects in the product but also to consider the presence of particular sensory characteristics (Endrizzi *et al*. 2012; Etaio *et al*. 2010; Etaio *et al*. 2012).

There are an important number of publications addressing how quality labels affect liking, decision-making and willingness to pay by consumers (Grunert and Aachmann 2016). However, references relating consumers´ liking with sensory quality scores obtained from trained panels are very scarce. In the case of dairy products, the methodology of the International Dairy Federation (IDF 1997) has been used for grading generic cheeses for commercial purposes (Hersleth *et al.* 2005; Kraggerud *et al.* 2012). In this method, three sensory quality parameters (appearance, consistency and flavor) are evaluated by trained panels considering a 1-5 point interval scale where 1 corresponds with the lowest quality and 5 corresponds with the highest quality. In generic extra virgin olive oil, Barbieri *et al.* (2015) and Predieri *et al.* (2013) investigated the convergence between consumers´ liking and sensory quality obtained by using the European official sensory method (European Community, 2008). In this method the intensity of positive and negative characteristics is evaluated by using a 10 point continuous scale. There is also a work studying the correlation between the sensory quality scores of

coffee from Ethiopia evaluated by an exporter (Ethiopia Commodity Exchange (ECX) cupping center) and the scores from an importer in Europe (EFICO Agency SA), the latter reflecting to some extent the preferences of the European coffee consumers (Worku *et al.* 2016). In spite of the studies of generic food products mentioned, studies dealing with agreement between consumer likes and sensory quality in specific traditional products have not been found.

PDO Idiazabal cheese is a traditional food product from the Basque Country (in the North of Spain) made with raw ewes´ milk of the autochthonous Latxa breed and with a ripening time of at least two months. This product has a very marked cultural, social, economic and environmental background (Pérez Elortondo 1996). The official sensory quality control of this product is carried out by a trained panel in the Sensory Laboratory of the University of the Basque Country (LASEHU), which has been accredited following standard ISO 17025 (ISO, 2005) since 2005. PDO Idiazabal cheese is recognized as a high quality product (it has won many awards in national and international competitions) and it is much appreciated by consumers in the Basque Country. Several publications have dealt with the sensory characterization of PDO Idiazabal cheese (Bárcenas *et al.* 2001; Ordóñez *et al.* 1998) and the development of a specific methodology for its official sensory quality control (Ojeda *et al.* 2015; Pérez Elortondo *et al.* 2007). However, there is no information about consumer preferences for PDO Idiazabal cheeses with different sensory qualities.

The main objective of this study was to determine if the likes of local consumers matched with the sensory quality of the cheese samples assessed by the official trained panel. Also, this work explores the sensory drivers leading consumers' preferences and the effect of socio-demographic characteristics and objective and subjective knowledge about cheese on liking for this product.

2. Materials and methods

2.1. Sample selection and preparation

Cheese samples were selected from a set of 88 non-smoked cheeses evaluated from June to July in the context of the official sensory quality control of PDO Idiazabal cheese in LASEHU. Nine cheeses were chosen taking into account three different quality levels: three samples from the first quartile

(cheeses with the highest quality scores), three samples between percentiles 40 and 60 (cheeses with medium quality scores) and three samples from the four quartile (cheeses with the lowest quality scores).

After checking that the nine cheese producers still kept enough samples from the same batch of the selected cheese, 20 units of each cheese (of around 1.2 kg) were collected and stored in the ripening chamber of a cheese farm at 9 ± 2 ºC until their assessment in October, when they had reached five-six months of ripening. One week before testing, cheeses were moved to the laboratory and kept in a fridge at 5 ± 3 ºC. The night previous to the analysis, samples were placed in a cellar at 17 ± 2 ºC. Each cheese was cut into pieces of 1 cm x 1 cm x 5 cm and served in plastic trays to the assessors (trained assessors or consumers, depending on the trial). Samples were codified with three digits and presented according to a Williams Latin square design, so sample-order associated bias was avoided. Sample temperature was 19 ± 3 ºC when they were evaluated.

2.2. Sensory quality evaluation by the trained panel

Sensory analysis was performed in the Sensory Laboratory of the University of the Basque Country (LASEHU), by eight members (two male and six female, with an average age of 42) of the official trained panel for the sensory quality control of PDO Idiazabal cheese. Selection, training and performance of the assessors took place according to Pérez Elortondo *et al.* (2007). These assessors have been taking part in the sensory quality control on PDO Idiazabal cheese for more than 10 years, being over 100 the number of samples that each assessor evaluate each year.

The evaluation methodology was the sensory quality control method for PDO Idiazabal cheese certification described by Ojeda *et al.* (2015). This methodology employs a scorecard including eight sensory parameters: quality related to odor, texture, flavor, persistence, shape, rind, color paste and eyes. The evaluation consists in the identification of sensory characteristics (appropriate, not totally appropriate and defective) for each sensory parameter. According to the characteristics identified and by means of a decision tree, a quality score is given to each parameter in a 1-7 point discontinuous scale. In this scale, point 7 is the "top" sensory situation where characteristics of typicity are

considered, 4-6 range covers not totally appropriate characteristics and 1-3 range covers defective sensory characteristics.

For the present study, the analysis was conducted only for odor, texture, flavor and persistence parameters. The evaluation of the nine samples was carried out in two sessions on different days of the same week in order to have two replications. Both sensory characteristics and scores were collected by using FIZZ software 2.40H (Biosystemes, Couternon, France).

Assessment was carried out in individual booths designed according to the standard ISO 8589 (ISO, 2007). A waiting time of one minute between samples was programmed. Assessors chewed apple and rinsed their mouth with water between samples to eliminate residual sensations.

2.3. Assessment of liking by consumers

Two hundred and twelve consumers living in Vitoria-Gasteiz city (Basque Country) participated in this research. They were recruited from previous databases and by using different media (radio, e-mails, social networking sites and posters on the university campus). Consumers who expressed their willingness to participate were asked about gender, age, region of residence and cheese consumption frequency. Only consumers from Vitoria-Gasteiz with a cheese consumption of at least once a month were recruited, while a balanced distribution regarding gender and age ranges (18-29, 30-44, 45-59, ≥ 60) was also sought.

The consumer study was carried out over 14 sessions of about 45 minutes for four days of the same week. These trials were carried out a week after the sensory analysis by the trained panel so it can be supposed that the effect of further cheese ripening was negligible. Up to sixteen consumers took part in each session evaluating the nine samples in individual booths under white light at 21 ± 2 °C. No information about the aim of the study was provided to them (they only knew that they were participating in a "cheese study"). Participants were asked to fill in four different questionnaires on paper forms. In the first questionnaire consumers were asked to score the samples for liking on a discontinuous 9-point scale structured as follow: 1-"dislike extremely", 2-"dislike very much", 3-"dislike moderately", 4-"dislike slightly", 5-"neither like nor dislike", 6-"like slightly", 7-"like

moderately", 8-"like very much" and 9-"like extremely". Consumers were allowed to taste the cheeses as many times as they wanted, although they were advised not to test the same sample many times to avoid fatigue. Also, they were instructed to have breaks of about one minute between contiguous samples and to chew apple and rinse mouths with water during the break to eliminate residual sensations.

Secondly, consumers were provided with a questionnaire to indicate the level of knowledge about cheese they thought they had (subjective knowledge). A discontinuous 7-point scale structured from "low knowledge" on the left to "high knowledge" on the right was used. For data treatment purposes, a score ≤ 2 was considered as "low knowledge", from 3 to 5 as "medium knowledge" and ≥ 6 as "high knowledge". Next, objective knowledge was evaluated by means of ten questions about cultural and technical aspects of cheeses with multiple choice answers (Fig. 1). The questionnaire provided a mark for each consumer from 0 to 100 as a result of assigning 10 points to each right answer. For data treatment purposes, 0 to 29 points was considered as "very low knowledge", 30 to 49 points as "low knowledge" and ≥ 50 points as "medium – high knowledge". Finally, the fourth questionnaire consisted of questions about socio-demographic characteristics and cheese consumption habits. Upon completing the session, consumers received a gift for their participation.

2.4. Data analysis

Overall sensory quality (OSQ) for each sample, session and assessor was calculated by applying the following equation (based on the criteria of the Regulatory Council of PDO Idiazabal cheese as described by Pérez Villarreal *et al.* (1995)): OSQ = odor quality x 0.20 + texture quality x 0.25 + flavor quality x 0.35 + persistence quality x 0.20.

A three-way ANOVA was applied on OSQ values from each assessor (and also on sensory quality scores for odor, texture, flavor and persistence) to study the possible statistical differences among cheeses ($P < 0.05$). Product (cheese), assessor and session were considered as fixed factors and all first order interactions were included in the model. Tukey´s honest significant difference (HSD) test was also applied to identify pair of products significantly different.

Regarding consumers´ data, a two-way ANOVA was performed on individual liking scores considering product (cheese) as fixed factor and consumer as random effect. Tukey´s HSD test was applied to identify pair of products significantly different. In order to check if each consumer individually agreed with the trained panel, Pearson correlation coefficient was calculated considering individual liking scores and OSQ mean scores from the trained panel. Next, consumers were grouped in six categories according to this coefficient ($r \geq 0.7$ high correlation, $0.4 \leq r < 0.7$ medium correlation, $r < 0.4$ low correlation) and its sign (positive or negative). In order to visualize consumer groups´ preferences for each of the nine samples in a two-dimensional space, an internal preference mapping was performed on the individual liking data.

In order to study the sensory drivers leading consumers´ liking, the citation frequency (CF) of each sensory characteristic by the trained panel was considered. CF was calculated as the number of times (in percentage) that each characteristic was cited for each sample over the total number of times that it could be cited (8 assessors x 2 sessions = 16 times). In order to study differences among products, Cochran´s Q test was carried out on sensory characteristics presenting a $CF \geq 15\%$ for all the samples considered together or when any of the samples presented a $CF \geq 25\%$. A contingency table (cheese samples in rows and sensory characteristics in columns) containing the number of citations of each sensory characteristic by the trained panel for each cheese sample was prepared and a simple correspondence analysis (CA) was carried out. Then, average liking for each cheese sample was modelled for each group of consumers as a function of the first two dimensions of the CA using an external preference mapping. Linear and circular models were tested. In order find the best model, an F-ratio test, with a 25% of significance level, was used.

All these analysis were run with the XLSTAT statistical software 2011 (Addinsoft, Paris, France).

Finally, Chi-square (χ^2) test with Yates´s correction was applied for finding significant differences ($P < 0.05$) within each group and among groups for each aspect considered in the four questionnaires (subjective and objective knowledge, socio-demographic aspects and cheese consumption habits). This test was carried out on http://quantpsy.org (Preacher, 2001).

3. Results and discussion

3.1. Consumers´ characterization

Information characterizing consumers from questionnaires two to four is shown in Table 1. 83.5% of the participants were habitual consumers of cheese (32.1% daily or almost daily and 51.4 % once or several times a week). Regarding type of cheese, hard cheese was the most consumed (56.6% of the participants) followed by semi-hard cheese (30.2 % of the participants). With regard to the origin of the milk for the cheese, the majority of participants (74.5 %) mostly consumed ewe / goat´s milk cheeses. With regard to knowledge about cheese, while 77.4% of consumers claimed medium subjective knowledge only 17.9% showed medium-high knowledge according to the third questionnaire.

3.2. Relationship between sensory quality and consumers´ liking

Mean quality scores and standard deviation from the trained panel for odor, texture, flavor and persistence related quality and for OSQ of the nine cheeses are shown in Table 2, as well as significant differences ($P < 0.05$) among samples. These results confirmed that cheese samples had different sensory qualities. Sample 9 presented significant higher OSQ than samples 1 to 6. By contrast, OSQ of samples 1 and 2 was significantly lower than the other seven samples. Regarding consumers´ liking, there were also significant ($P < 0.05$) differences among cheeses. In the same way as observed for OSQ, sample 9 was significantly more appreciated than samples 1 to 6. At the same time, liking for samples 1 and 2 was lower than for the other seven samples.

Cheeses with the highest OSQ (cheese 7, 8 and 9) had the highest liking scores and cheeses with the lowest OSQ (cheese 1 and 2) were the least appreciated by consumers. When studying individual relationships between liking and OSQ (Table 3), a different pattern of preference was observed among the consumers. The majority of the consumers (77.4%) presented a positive correlation with the OSQ from the trained panel. On the contrary, there was a minor group of consumers (22.6 %) with a negative correlation between their liking and the OSQ. Within each group, consumers were grouped in three categories according to Pearson correlation coefficient (low: r < 0.4; medium: 0.4 ≤ r < 0.7;

high: r ≥ 0.7). As the number of consumers with high and medium negative correlation was very low, they were gathered in the same group. The distribution of the consumers of the resulting five groups and their preference towards the nine samples can be visualize in Fig. 2. Grupo 1 was composed of 16 consumers who preferred samples 1, 3 and to a certain extend sample 2. Conversely, groups 4 and 5, composed of 52 and 42 consumers respectively, clearly preferred cheeses 7, 8 and 9. Regarding consumers from groups 2 and 3 (32 and 70 respectively), they appear much dispersed across Y-axis of the sensory space, showing a less clear preference toward the samples.

The existence of groups of consumers whose acceptability is not in accordance with sensory quality assessed by a trained panel has been reported in other studies with Norwegian cheeses. Hersleth *et al.* (2005) found a group of consumers preferring the sample with the lowest quality score. According to these authors, low levels of sensory defects in dairy products may not always be objectionable to consumers. Kraggerud *et al.* (2012) identified two clusters of consumers (29.1% and 34.1%) in disagreement with the trained panel scoring sensory quality. These authors interpreted this finding by arguing that a large number of consumers would prefer other sensory characteristics than those present in the evaluated cheeses.

Regarding characterization of the different groups of consumers by Chi-square (χ2) test with Yates´s correction, a significant (P < 0.05) higher percentage of young consumers (less than 30 years) was observed in group 5 (the group with the higher agreement with the trained panel) (data not shown). No other significant particularities in relation to socio-demographic characteristics, cheese consumption habits and knowledge about cheese were observed among consumers' groups.

3.3. Sensory characteristics driving consumers´ liking

Results from Cochran´s Q test showed significant differences (*P* < 0.05) among samples for 45 of the 81 characteristics cited by any member of the panel: 9 of odor (2 as appropriate characteristic, AC; 5 as not totally appropriate characteristic, NTAC; and 2 as defective characteristic, DC), 11 of texture (3 AC, 5 NTAC and 3 DC), 16 of flavor (6 AC, 7 NTAC and 3 DC) and 9 of persistence (6 NTAC and 3 DC).

Fig. 3 represents the correspondence analysis performed on the CF for each sensory characteristic in each sample. It explains 62.60% of the variance of the experimental data (44.02% and 18.58% in the first and second dimension, respectively). In Fig. 4, the external preference map is shown. This map includes the position of vectors indicating the direction of maximum preference for each group of consumers. The distribution of the groups of consumers confirms the existence of two different main patterns, as stated previously (Fig. 2). One pattern is related to group 1 and, to a certain extent, to group 2. The other pattern is related to groups 4 and 5 and, to a lesser degree, to group 3.

The acceptability of groups 4 and 5 was mainly determined by characteristics as "toasty" (odor, flavor and persistence), "sweet" (taste and persistence), "acid" (persistence), "rancid" (flavor), "absence of bitter" (taste) and "no deformation" (texture). With the exception of "absence of bitter" taste they all were not totally appropriate characteristics. It is worth noting that "toasty" and "sweet" characteristics were associated with sample 9. Regarding group 3, drivers of liking are similar to groups 4 and 5 although less noticeable, probably due to the fact that consumers from group 3 were less discriminative (Figure 2 and Table 3). This finding suggests that consumers of these groups might prefer intense "toasty" and "sweet" cheeses than the characteristic odor defined for PDO Idiazabal cheese.

Conversely, maximum liking for group 1 was mainly oriented towards products 1 and 2. As shown in Fig. 3, the acceptability was determined by "animal" (odor, flavor and persistence), "rancid" (odor, flavor and persistence), "bitter" (flavor and persistence) and the absence of "milky" odor. With the exception of absence of "milky" odor (not totally appropriate characteristic), they all were defective characteristics for PDO Idiazabal cheese. Consumers of group 2 would have similar sensory drivers, although with a clearer tendency for "animal" character. This fact suggests that these groups of consumers probably like cheese with some "strong" characteristics. The liking toward some characteristics considered as defective could also have a habituation component. Habit is a strong determinant of individual preferences that, in some cases, can explain the preference for defective food products (Guerrero *et al.* 2009; Guerrero *et al.* 2012). For example, in a study with virgin olive

oils, Guerrero *et al.* (2012) found that 49.25% of consumers preferred a sample with "fusty/muddy sediment" defect.

The opposition between the "strong" characteristics mentioned ("animal", "rancid", "bitter") and "mild" characteristics ("toasty" and "sweet") could explain the segmentation into two main groups of consumers. In fact, this division of sensory characteristics observed in this work was to a great extend similar to that reported by Bárcenas *et al.* (2001) in a study on Spanish ewes' milk cheeses. These authors found the existence of two clearly different groups of sensory terms: on the one hand "strong or very intense sensory characteristics" ("animal", "sharp", "brine", "rennet" and "butyric acid"), and on the other hand, characteristics that could be defined as "mild or soft" ("milky", "toasty", "buttery", "nutty" and "sweet"). Caspia *et al.* (2006) identified in Cheddar cheeses two groups of sensory characteristics: one group was characterized by "sweet", "buttery" "creamy" and "cooked" opposed to a group characterized by "earthy", "sulfur", "free fatty acid", "sour", "bitter", "pungent" and "prickle bite".

As previous studies reveled, the preference of consumers for "mild or soft" characteristics appears to be widespread to cheese consumers. Gonzalez Viñas *et al.* (1999) compared ten commercial Spanish ewe milk cheeses with a survey of 43 students and concluded that this group of young consumers preferred "milder" cheeses to those with very "strong" characteristics. In a study with Cheddar cheeses, Caspia *et al.* (2006) found that 65% of consumers liked samples with "buttery", "creamy", "sweet" and "cooked" flavor.

Conversely, there is evidence that bitterness is not a desirable cheese characteristic for some consumers, as reported by several authors (Arcia *et al.* 2013; Bord *et al.* 2017; Caspia *et al.* 2006; Young *et al.* 2004; Zhang *et al.* 2011). A dislike for "bitter" taste has also been studied in other food products than cheese, such as whole-grain products (Bakke and Vikers 2007), extra virgin olive oils (Barbieri *et al.* 2015; Delgado and Guinard 2011; Recchia *et al.* 2012) or green vegetables (Chadwick *et al.* 2016; Dinnella *et al*. 2016; Poelman *et al.* 2017). This fact might be due to bitter perception playing a role in human activities by evoking a defense mechanism to prevent the ingestion of harmful

substances (Chandrashekar *et al.* 2000). Even though there are individuals who like these substances, humans learn to like bitter foods by experience (Garcia-Burgos and Zamora 2015).

With regard to texture characteristics, these play a minor role in influencing consumer liking (Fig. 3 and Fig. 4) compared to odor and flavor. In this sense, Bárcenas *et al.* (2003) reported that odor characteristics play an important role at the time of defining consumer preference for ewes' milk cheeses. In the study on Cheddar cheese, Caspia *et al.* (2006) demonstrated that texture could not be used to relate descriptive sensory analysis to consumer acceptance, whereas flavor characteristics fitted well with it. Arcia *et al.* (2013) showed that differences in flavor dictated the differences in consumers´ acceptance of Uruguayan "queso magro" low-fat cheese. Other authors, has also determined that flavor was more a driving force in overall liking of different cheeses (raw milk cheeses) than texture (Liggett *et al.* 2008; Yates and Drake 2007; Young *et al.* 2004). However, in a study on PDO Blue-veined cheese, Bord *et al.* (2017) found that texture characteristics were the key sensory drivers of liking for 48.4 % of consumers. So, the influence of the texture on the consumers´ preferences could also be influenced by the kind of cheese.

4. Conclusions

The current study showed that in the case of PDO Idiazabal cheese, acceptability of most consumers agreed to a considerable extent with the official sensory quality determined by the official trained panel of the Regulatory Council. In spite of majority of consumers from Vitoria-Gasteiz preferring PDO Idiazabal cheeses with high quality, different liking patterns were found among consumers. Liking of consumers in agreement with the trained panel was mainly driven by "sweet" and "toasty" characteristics, whereas tastes of the small group of consumers disagreeing with the trained panel were related to some defective sensory characteristics, such as "animal", "rancid" and "bitter". Regulatory Council could take advantage of the results of this study to increase the effort to help the consumers to identify the sensory characteristics of this particular product, with special attention to consumers with preferences towards defective cheeses.

Further research should explore if non-local consumers´ liking also fits the sensory quality scored by an official trained panel, thus considering the possible cross-cultural influences.

5. Acknowledgments

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Consumer number: Date: Hour:

Please, mark only one answer for each question:

1. Mark the origin of the milk for each kind of cheese:

Cheese	Origin of the milk		
Gouda	Cow □	Ewe □	I do not know □
Idiazabal	Cow □	Ewe □	I do not know □
Camembert	Cow □	Ewe □	I do not know □
Gorgonzola	Cow □	Ewe □	I do not know □
Manchego	Cow □	Ewe □	I do not know □

2. Which of the following cheeses has usually the rind covered by a mould layer?
1. Cheddar
2. Manchego
3. Camembert
4. Parmesan
5. I do not know

3. Which of the following cheeses is traditionally made with buffalo's milk?
1. Feta
2. Gorgonzola
3. Parmesan
4. Mozzarella
5. I do not know

4. What is the rennet?
1. It is the product resulting from the coagulation of the milk proteins
2. It is a preparation with enzymes from animal origin, from vegetal origin or from mould origin
3. The bacteria that are added to the milk so that it ferments
4. A technological operation feature of "white paste cheeses"
5. I do not know

5. Which are the usual mechanisms to coagulate the milk?
1. The addition of bacteria and the addition of enzymes
2. Applying high temperature combined with milkshake
3. The addition of salt
4. The addition of acetic acid
5. I do not know

6. Which ewe´s breed does the milk used for making Idiazabal cheese come from?
1. Latxa and Merina
2. Assaf
3. Latxa and Carranzana
4. Hampshire and Churra
5. I do not know

7. What is the characteristic mould of the Roquefort cheese?
1. *Penicillium*
2. Acid-lactic bacteria
3. *Acetobacter*
4. *Aspergillus*
5. I do not know

8. Which of the following cheeses has a very hard texture?
1. Gruyere
2. Edam
3. Brie
4. Parmesan
5. I do not know

9. Which country is Edam cheese related to?
1. England
2. Greece
3. Italy
4. Netherlands
5. I do not know

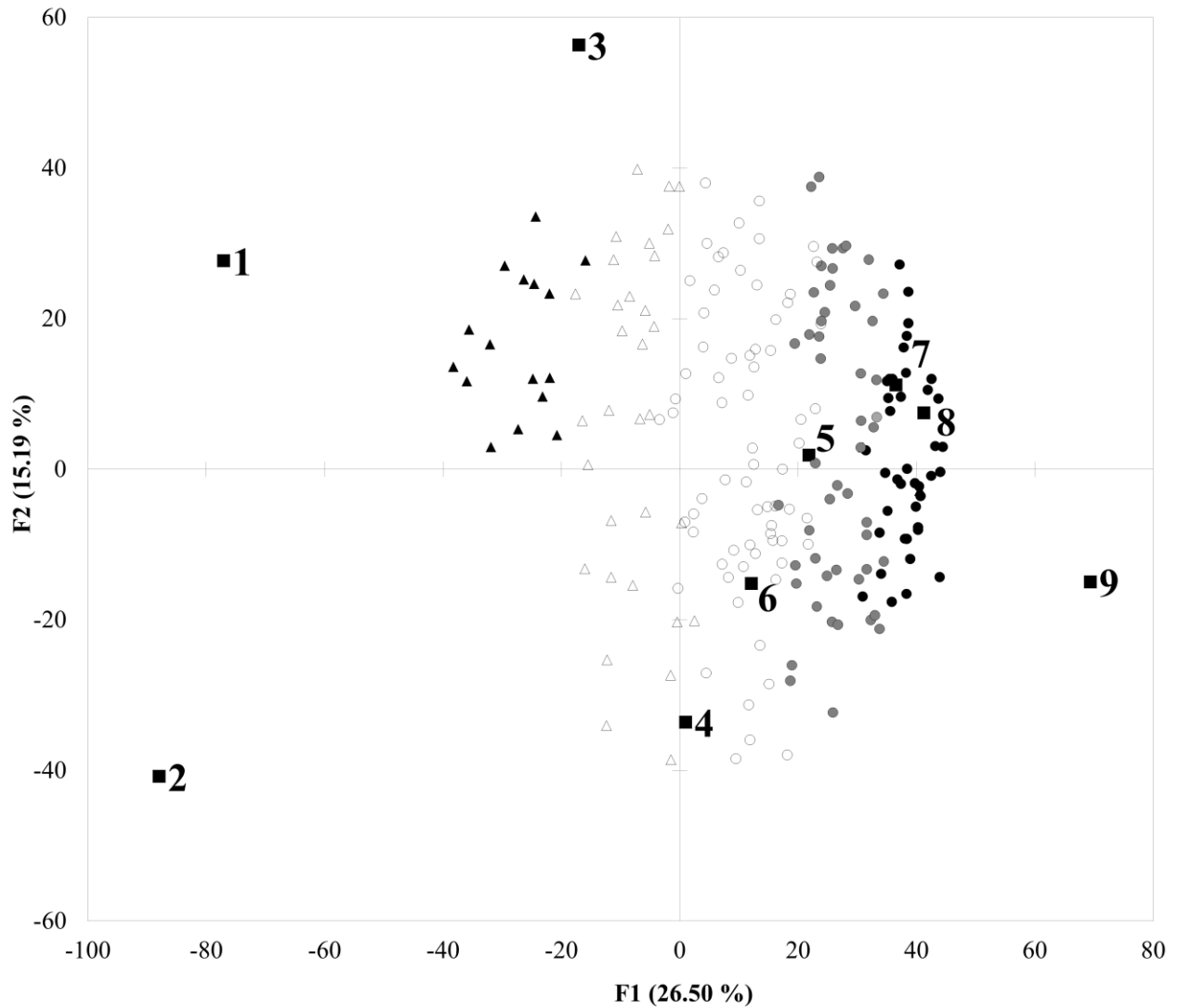**10. Which of the following cheeses has big and round holes?**
1. Parmesan
2. Cheddar
3. Emmental
4. Manchego
5. I do not know

Figure 1. QUESTIONNAIRE TO MEASURE OBJECTIVE KNOWLEDGE.

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Figure 2. INTERNAL PREFERENCE MAPPING OF CONSUMERS´ DATA (N = 212) WITH INDICATION OF THE LEVEL OF CORRELATION BETWEEN THE INDIVIDUAL LIKING AND THE OSQ FROM THE TRAINED PANEL: Consumer with negative correlation in triangles (in black = medium-high correlation; in white = low correlation) and consumers with positive correlation in circles (in black = high correlation, in grey = medium correlation, in white = low correlation). High correlation: $r \geq 0.7$; medium correlation: $0.4 \leq r < 0.7$; low correlation: $r < 0.4$.

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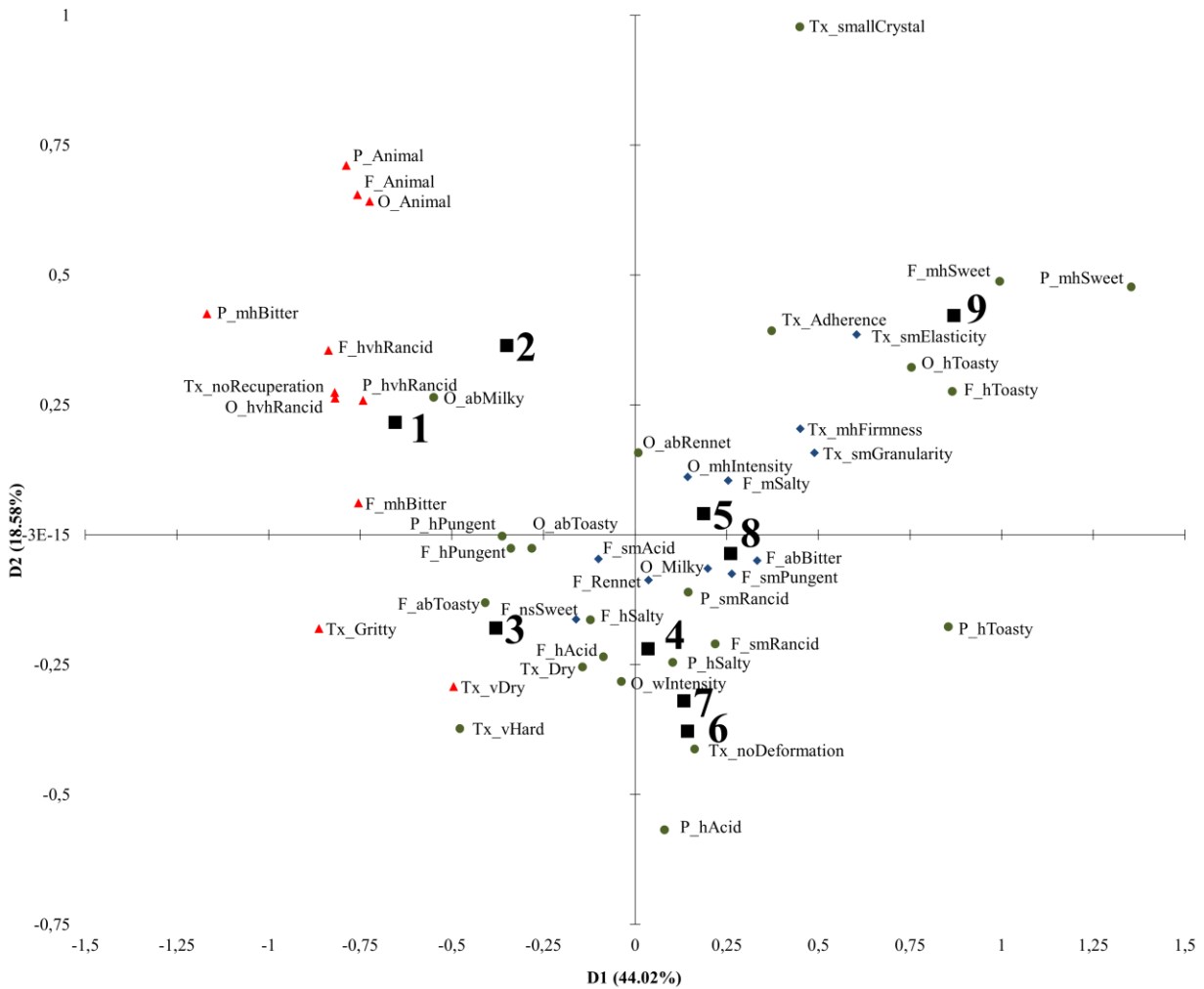
Figure 3. REPRESENTATION OF THE SIGNIFICANT (*P* < 0.05) SENSORY CHARACTERISTICS FROM THE COCHRAN´S Q TEST AND THE CHEESE SAMPLES (N = 9) OVER THE FIRST TWO COMPONENTS FROM THE SIMPLE CORRESPONDENCE ANALYSIS. Appropriate characteristics in rhombus, not totally appropriate characteristics in circles and defective characteristics in triangles. O = odor; Tx = texture; F = flavor; P = persistence. _ns = null to slight intensity; _sm = slight to medium intensity; _mh = medium to high intensity; _ab = absence of; _w = weak; _m = medium intensity; _h = high intensity; _v = very; _hvh = high to very high intensity.

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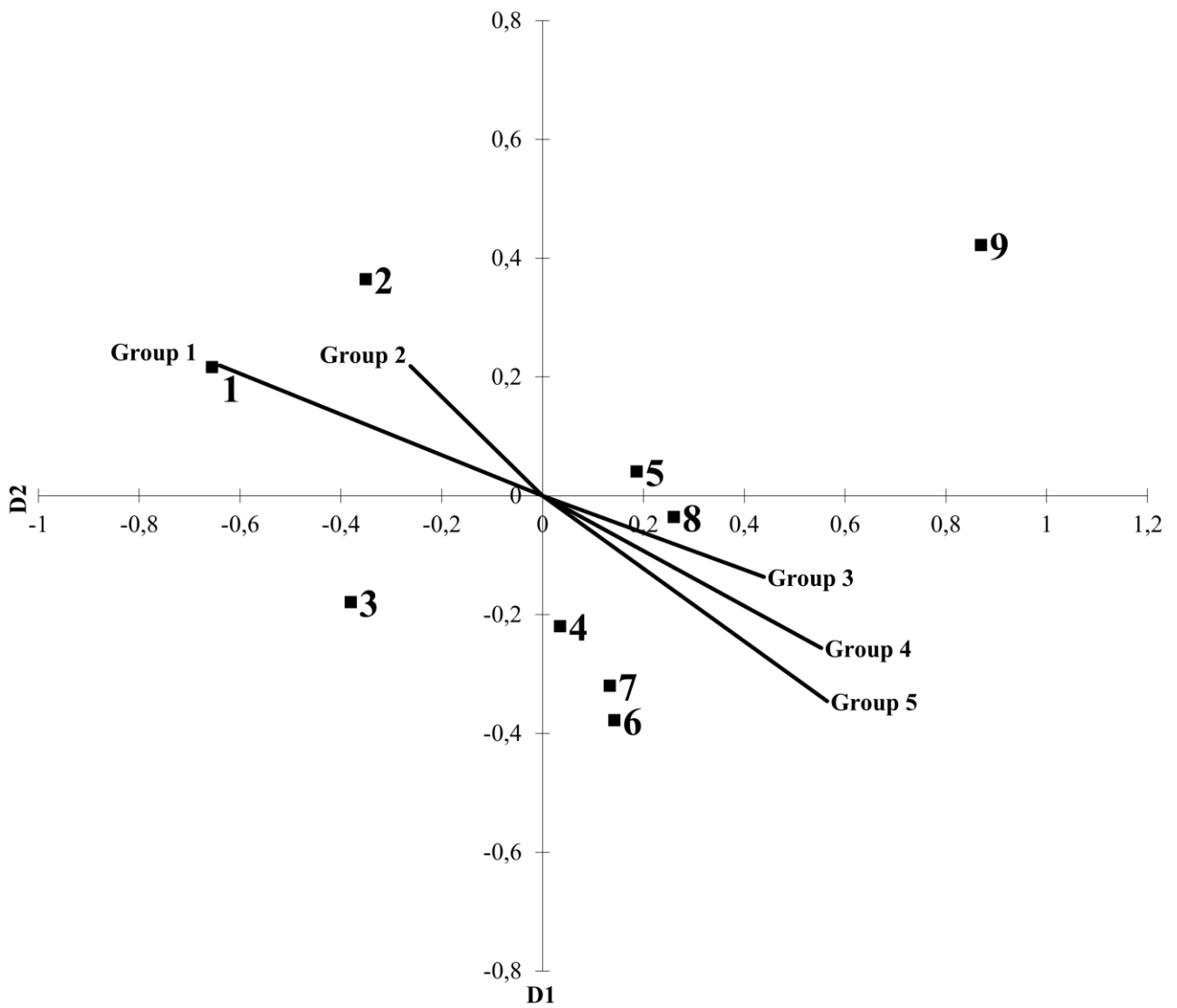
Figure 4. PREFERENCE MAPPING FROM THE SIMPLE CORRESPONDENCE ANALYSIS WITH REPRESENTATION OF CHEESE SAMPLES AND THE VECTOR OF MAXIMUM PREFERENCE FOR EACH OF THE FIVE GROUPS OF CONSUMERS IDENTIFIED.

484 **TABLE 1.** SOCIO-DEMOGRAPHIC CHARACTERISTICS AND CHEESE CONSUMPTION

485 HABITS OF PARTICIPANTS (DATA EXPRESSED AS NUMBER OF INDIVIDUALS AND, IN

486 BRACKETS, PERCENTAGE OVER THE WHOLE SAMPLE, (N=212).

Socio-demographic characteristics	N
Gender	
Female	112 (52.8)
Male	100 (47.2)
Age	
18-29	60 (28.3)
30-44	54 (25.5)
45-59	52 (24.5)
≥ 60	46 (21.7)
Education level	
Primary school	43 (20.3)
Secondary school	44 (20.7)
Vocational Education and Training	75 (35.4)
University	50 (23.6)
Work situation	
Student	43 (20.3)
Unemployed	55 (25.9)
Pensioner	38 (17.9)
Worker	76 (35.9)
Cheese consumption frequency	
Daily or almost daily	68 (32.1)
Once a week / several times a week	109 (51.4)
Once a month / several times a month	35 (16.5)
Type of cheese mostly consumed	
Fresh soft cheese	15 (7.1)
Semi-hard cheese	64 (30.2)
Hard cheese	120 (56.6)
No answer	13 (6.1)
Origin of the milk of the cheese mostly consumed	
Cow	40 (18.9)
Ewe / goat	158 (74.5)
No answer	14 (6.6)

Subjective knowledge about cheese [a]

Low knowledge (score ≤ 2)	41 (19.3)
Medium knowledge (score from 3 to 5)	164 (77.4)
High knowledge (score ≥ 6)	7 (3.3)

Objective knowledge about cheese [b]

Very low knowledge (0 – 29 points)	92 (43.4)
Low knowledge (30 – 49 points)	82 (38.7)
Medium - high knowledge (≥ 50 points)	38 (17.9)

487   [a] Answer scale ranged from 1 (low knowledge) to 7 (high knowledge).

488   [b] Grade from 0 to 100.

TABLE 2. MEAN AND STANDARD DEVIATION (SD), FOR THE SENSORY PARAMETERS EVALUATED BY THE

TRAINED PANEL AND FOR CONSUMERS´ LIKING FOR THE CHEESES.

	Sensory parameters evaluated by the trained panel										Liking from consumers	
	Odor		Texture		Flavor		Persistence		OSQ			
Cheese	Mean	SD[a]	Mean	SD[a]	Mean	SD[a]	Mean	SD[a]	Mean	SD[a]	Mean	SD
1	3.2 c	0.61	2.8 e	0.64	2.6 e	0.53	2.5 d	0.53	2.7 e	0.50	5.2 e	1.98
2	2.3 d	1.14	3.9 bc	0.69	2.3 e	0.87	2.3 d	1.04	2.7 e	0.74	5.0 e	1.95
3	3.7 bc	1.06	3.1 de	0.35	3.6 cd	0.77	3.7 bc	0.64	3.5 d	0.47	6.0 bcd	1.88
4	4.1 ab	0.79	3.6 cd	0.91	3.8 bcd	1.08	3.8 bc	1.01	3.8 cd	0.82	5.7 d	1.55
5	4.3 ab	0.65	4.6 ab	0.53	3.4 d	0.92	3.4 c	0.99	3.9 cd	0.64	6.2 bcd	1.56
6	4.3 ab	0.69	4.3 abc	0.49	4.1 abcd	1.18	3.9 bc	0.88	4.2 bc	0.71	5.8 cd	1.62
7	4.5 ab	0.91	4.0 abc	0.46	4.4 abc	0.91	4.3 ab	0.80	4.3 abc	0.64	6.3 ab	1.47
8	4.4 ab	0.92	4.7 a	0.83	4.6 ab	0.82	4.4 ab	0.74	4.5 ab	0.63	6.3 abc	1.57
9	4.9 a	0.76	4.4 ab	0.75	4.9 a	0.59	4.8 a	0.69	4. 8 a	0.40	6.6 a	1.52

Within a column, different letters indicate significant differences between cheese samples ($P < 0.05$) according to Tukey´s

HSD test.

[a] SD for trained panel was calculated as the mean score of SD of session 1 and SD of session 2.

TABLE 3. MEAN LIKING SCORES PER SAMPLE AND GROUP OF CONSUMERS CATEGORIZED ACCORDING

TO THEIR PEARSON CORRELATION COEFFICIENT (r) BETWEEN OVERALL SENSORY QUALITY (OSQ)

AND INDIVIDUAL LIKING.

	Negative correlation between liking and OSQ			Positive correlation between liking and OSQ			
	High[a] and Medium[b]	Low[c]	Global	Low	Medium	High	Global
	Group 1		Group 2	Group 3	Group 4	Group 5	
Cheese	(n = 16)	(n = 32)	(n = 48)	(n = 70)	(n = 52)	(n = 42)	(n = 164)
1	7.6a	6.3	6.8 a	5.3 d	4.6 de	4.1 e	4.8 d
2	6.6 ab	6.4	6.5 ab	5.3 cd	4.3 e	3.4 e	4.5 d
3	7.1 a	6.4	6.6 a	6.1 abc	5.7 c	5.4 d	5.8 c
4	5.8 bc	5.6	5.7 bc	5.9 abcd	5.4cd	5.9 cd	5.7 c
5	5.8 bc	6.4	6.2 abc	6.2 ab	6.0 bc	6.3bc	6.1 bc
6	5. 6 c	5.9	5.8 bc	5.6 bcd	5.9 bc	6.2 bc	5.9 c
7	6.0 bc	6.0	6.0 abc	6.1 abc	6.5 ab	6.8 ab	6.4 ab
8	5.6 bc	5.5	5.6 c	6.1 abcd	6.6ab	7.0 a	6.5 ab
9	5.3 c	5.8	5.7 c	6.5 a	7.0 a	7.5 a	6.9 a

Within a column, different lower case letters represent significant differences ($P < 0.05$) between samples according to Tukey´s HSD test.

[a] $r \geq 0.7$

[b] $0.4 \leq r < 0.7$

[c] $r < 0.4$