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**DOES CONSUMER LIKING FIT THE SENSORY QUALITY  
ASSESSED BY TRAINED PANELISTS IN TRADITIONAL FOOD  
PRODUCTS? A STUDY ON PDO IDIAZABAL CHEESE**

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Keywords:	PDO Idiazabal cheese; sensory quality control; trained panel; consumers' liking; sensory drivers
Abstract:	<p>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</p>

	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.

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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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18

## 19 **Abstract**

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

## 32 **Practical Applications**

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

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

## 42 **Keywords**

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

44

## 45 1. Introduction

46 The food industry usually focuses on consumer preferences when establishing sensory quality  
47 control programs (Muñoz 2002; Pecore and Kellen 2002). However, there are certain traditional  
48 food products certified with quality labels where consumers' preferences should have less influence  
49 on the sensory quality definition than in the case of conventional foods (Ojeda et al., 2015). This is  
50 the case of the food products with PDO (EU 2012), which are expected to present some distinctive  
51 sensory characteristics linked to their origin, raw materials and traditional practices (Ballester *et al.*  
52 2005). Taking into account that an important goal of a PDO is to offer high quality products, it is  
53 necessary to define and control objectively their sensory characteristics in order to guarantee their  
54 authenticity and those sensory characteristics that differentiate them from similar commercial  
55 products (Bertozzi and Panari 1993). As a basis for the certification of the product, sensory quality  
56 control of PDO products requires both the development of a specific evaluation method as well as a  
57 trained panel to not only guarantee the absence of defects in the product but also to consider the  
58 presence of particular sensory characteristics (Endrizzi *et al.* 2012; Etaio *et al.* 2010; Etaio *et al.*  
59 2012).

60 There are an important number of publications addressing how quality labels affect liking, decision-  
61 making and willingness to pay by consumers (Grunert and Aachmann 2016). However, references  
62 relating consumers' liking with sensory quality scores obtained from trained panels are very scarce.  
63 In the case of dairy products, the methodology of the International Dairy Federation (IDF 1997) has  
64 been used for grading generic cheeses for commercial purposes (Hersleth *et al.* 2005; Kraggerud *et*  
65 *al.* 2012). In this method, three sensory quality parameters (appearance, consistency and flavor) are  
66 evaluated by trained panels considering a 1-5 point interval scale where 1 corresponds with the  
67 lowest quality and 5 corresponds with the highest quality. In generic extra virgin olive oil, Barbieri  
68 *et al.* (2015) and Predieri *et al.* (2013) investigated the convergence between consumers' liking and  
69 sensory quality obtained by using the European official sensory method (European Community,  
70 2008). In this method the intensity of positive and negative characteristics is evaluated by using a

71 10 point continuous scale. There is also a work studying the correlation between the sensory quality  
72 scores of coffee from Ethiopia evaluated by an exporter (Ethiopia Commodity Exchange (ECX)  
73 cupping center) and the scores from an importer in Europe (EFICO Agency SA), the latter  
74 reflecting to some extent the preferences of the European coffee consumers (Worku *et al.* 2016). In  
75 spite of the studies of generic food products mentioned, studies dealing with agreement between  
76 consumer likes and sensory quality in specific traditional products have not been found.

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

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

## 93 **2. Materials and methods**

### 94 **2.1. Sample selection and preparation**

95 Cheese samples were selected from a set of 88 non-smoked cheeses evaluated from June to July in  
96 the context of the official sensory quality control of PDO Idiazabal cheese in LASEHU. Nine

97 cheeses were chosen taking into account three different quality levels: three samples from the first  
98 quartile (cheeses with the highest quality scores), three samples between percentiles 40 and 60  
99 (cheeses with medium quality scores) and three samples from the four quartile (cheeses with the  
100 lowest quality scores).

101 After checking that the nine cheese producers still kept enough samples from the same batch of the  
102 selected cheese, 20 units of each cheese (of around 1.2 kg) were collected and stored in the ripening  
103 chamber of a cheese farm at  $9 \pm 2$  °C until their assessment in October, when they had reached five-  
104 six months of ripening. One week before testing, cheeses were moved to the laboratory and kept in  
105 a fridge at  $5 \pm 3$  °C. The night previous to the analysis, samples were placed in a cellar at  $17 \pm 2$  °C.

106 Each cheese was cut into pieces of 1 cm x 1 cm x 5 cm and served in plastic trays to the assessors  
107 (trained assessors or consumers, depending on the trial). Samples were codified with three digits  
108 and presented according to a Williams Latin square design, so sample-order associated bias was  
109 avoided. Sample temperature was  $19 \pm 3$  °C when they were evaluated.

## 110 2.2. Sensory quality evaluation by the trained panel

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

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



123 discontinuous scale. In this scale, point 7 is the “top” sensory situation where characteristics of  
124 typicality are considered, 4-6 range covers not totally appropriate characteristics and 1-3 range covers  
125 defective sensory characteristics.

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

130 Assessment was carried out in individual booths designed according to the standard ISO 8589 (ISO,  
131 2007). A waiting time of one minute between samples was programmed. Assessors chewed apple  
132 and rinsed their mouth with water between samples to eliminate residual sensations.

### 133 **2.3. Assessment of liking by consumers**

134 Two hundred and twelve consumers living in Vitoria-Gasteiz city (Basque Country) participated in  
135 this research. They were recruited from previous databases and by using different media (radio, e-  
136 mails, social networking sites and posters on the university campus). Consumers who expressed  
137 their willingness to participate were asked about gender, age, region of residence and cheese  
138 consumption frequency. Only consumers from Vitoria-Gasteiz with a cheese consumption of at  
139 least once a month were recruited, while a balanced distribution regarding gender and age ranges  
140 (18-29, 30-44, 45-59,  $\geq 60$ ) was also sought.

141 The consumer study was carried out over 14 sessions of about 45 minutes for four days of the same  
142 week. These trials were carried out a week after the sensory analysis by the trained panel so it can  
143 be supposed that the effect of further cheese ripening was negligible. Up to sixteen consumers took  
144 part in each session evaluating the nine samples in individual booths under white light at  $21 \pm 2$  °C.  
145 No information about the aim of the study was provided to them (they only knew that they were  
146 participating in a “cheese study”). Participants were asked to fill in four different questionnaires on  
147 paper forms. In the first questionnaire consumers were asked to score the samples for liking on a  
148 discontinuous 9-point scale structured as follow: 1-“dislike extremely”, 2-“dislike very much”, 3-

149 “dislike moderately”, 4-“dislike slightly”, 5-“neither like nor dislike”, 6-“like slightly”, 7-“like  
150 moderately”, 8-“like very much” and 9-“like extremely”. Consumers were allowed to taste the  
151 cheeses as many times as they wanted, although they were advised not to test the same sample  
152 many times to avoid fatigue. Also, they were instructed to have breaks of about one minute between  
153 contiguous samples and to chew apple and rinse mouths with water during the break to eliminate  
154 residual sensations.

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

#### 167 **2.4. Data analysis**

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

172 To study the possible significative ( $P < 0.05$ ) differences among the sensory quality of the samples  
173 different analysis were used. As there was no normality in the distribution of the scores for odor,  
174 flavor, texture and persistence, Kruskal-Wallis test was applied (with Dunn’s test with Bonferroni’s

175 correction to study the differences between pairs of samples). As the distribution for OSQ was  
176 normal, a three-way ANOVA was applied for this parameter, with product (cheese), assessor and  
177 session as fixed factors and all first order interactions included in the model. Tukey's honest  
178 significant difference (HSD) test was used to study the differences between samples.

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

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

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

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

### 205 **3. Results and discussion**

#### 206 **3.1. Consumers' characterization**

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

#### 215 **3.2. Relationship between sensory quality and consumers' liking**

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

224 Cheeses with the highest OSQ (cheese 7, 8 and 9) had the highest liking scores and cheeses with the  
225 lowest OSQ (cheese 1 and 2) were the least appreciated by consumers. When studying individual  
226 relationships between liking and OSQ (Table 3), a different pattern of preference was observed

227 among the consumers. The majority of the consumers (77.4%) presented a positive correlation with  
228 the OSQ from the trained panel. On the contrary, there was a minor group of consumers (22.6 %)   
229 with a negative correlation between their liking and the OSQ. Within each group, consumers were  
230 grouped in three categories according to Pearson correlation coefficient (low:  $r < 0.4$ ; medium:  $0.4$   
231  $\leq r < 0.7$ ; high:  $r \geq 0.7$ ). As the number of consumers with high and medium negative correlation  
232 was very low, they were gathered in the same group. The distribution of the consumers of the  
233 resulting five groups and their preference towards the nine samples can be visualize in Fig. 2. Grupo  
234 1 was composed of 16 consumers who preferred samples 1, 3 and to a certain extend sample 2.  
235 Conversely, groups 4 and 5, composed of 52 and 42 consumers respectively, clearly preferred  
236 cheeses 7, 8 and 9. Regarding consumers from groups 2 and 3 (32 and 70 respectively), they appear  
237 much dispersed across Y-axis of the sensory space, showing a less clear preference toward the  
238 samples.

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

247 Regarding characterization of the different groups of consumers by Chi-square ( $\chi^2$ ) test with  
248 Yates's correction, a significant ( $P < 0.05$ ) higher percentage of young consumers (less than 30  
249 years) was observed in group 5 (the group with the higher agreement with the trained panel) (data  
250 not shown). No other significant particularities in relation to socio-demographic characteristics,  
251 cheese consumption habits and knowledge about cheese were observed among consumers' groups.

### 252 3.3. Sensory characteristics driving consumers' liking

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

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

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

274 Conversely, maximum liking for **group 1** was mainly oriented towards products 1 and 2. As shown  
275 in Fig. 3, the acceptability was determined by "animal" (odor, flavor and persistence), "rancid"  
276 (odor, flavor and persistence), "bitter" (flavor and persistence) and the absence of "milky" odor.  
277 With the exception of absence of "milky" odor (not totally appropriate characteristic), they all were  
278 defective characteristics for PDO Idiazabal cheese. **Consumers of group 2 would have similar**

279 sensory drivers, although with a clearer tendency for “animal” character. This fact suggests that  
280 these groups of consumers probably like cheese with some “strong” characteristics. The liking  
281 toward some characteristics considered as defective could also have a habituation component. Habit  
282 is a strong determinant of individual preferences that, in some cases, can explain the preference for  
283 defective food products (Guerrero *et al.* 2009; Guerrero *et al.* 2012). For example, in a study with  
284 virgin olive oils, Guerrero *et al.* (2012) found that 49.25% of consumers preferred a sample with  
285 “fusty/muddy sediment” defect.

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

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

303 Conversely, there is evidence that bitterness is not a desirable cheese characteristic for some  
304 consumers, as reported by several authors (Arcia *et al.* 2013; Bord *et al.* 2017; Caspia *et al.* 2006;

305 Young *et al.* 2004; Zhang *et al.* 2011). A dislike for “bitter” taste has also been studied in other food  
306 products than cheese, such as whole-grain products (Bakke and Vickers 2007), extra virgin olive oils  
307 (Barbieri *et al.* 2015; Delgado and Guinard 2011; Recchia *et al.* 2012) or green vegetables  
308 (Chadwick *et al.* 2016; Dinnella *et al.* 2016; Poelman *et al.* 2017). This fact might be due to bitter  
309 perception playing a role in human activities by evoking a defense mechanism to prevent the  
310 ingestion of harmful substances (Chandrashekar *et al.* 2000). Even though there are individuals who  
311 like these substances, humans learn to like bitter foods by experience (Garcia-Burgos and Zamora  
312 2015).

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

#### 325 **4. Conclusions**

326 The current study showed that in the case of PDO Idiazabal cheese, acceptability of most consumers  
327 agreed to a considerable extent with the official sensory quality determined by the official trained  
328 panel of the Regulatory Council. In spite of majority of consumers from Vitoria-Gasteiz preferring  
329 PDO Idiazabal cheeses with high quality, different liking patterns were found among consumers.  
330 Liking of consumers in agreement with the trained panel was mainly driven by “sweet” and



331 “toasty” characteristics, whereas tastes of the small group of consumers disagreeing with the trained  
332 panel were related to some defective sensory characteristics, such as “animal”, “rancid” and  
333 “bitter”.

334 Regulatory Council could take advantage of the results of this study to increase the effort to help the  
335 consumers to identify the sensory characteristics of this particular product, with special attention to  
336 consumers with preferences towards defective cheeses.

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

### 339 **5. Acknowledgments**

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342 Idiazabal cheese panel for their participation.

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457 **Figure captions**

458 **Figure 1.** QUESTIONNAIRE TO MEASURE OBJECTIVE KNOWLEDGE.

459 **Figure 2.** INTERNAL PREFERENCE MAPPING OF CONSUMERS' DATA (N = 212) WITH  
460 INDICATION OF THE LEVEL OF CORRELATION BETWEEN THE INDIVIDUAL LIKING  
461 AND THE OSQ FROM THE TRAINED PANEL: Consumer with negative correlation in triangles  
462 (in black = medium-high correlation; in light grey = low correlation) and consumers with positive  
463 correlation in circles (in black = high correlation, in dark grey = medium correlation, in light grey =  
464 low correlation). High correlation:  $r \geq 0.7$ ; medium correlation:  $0.4 \leq r < 0.7$ ; low correlation:  $r <$   
465  $0.4$ .

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

474 **Figure 3 (color version)** for color reproduction on the web and, **Figure 3 (black and white**  
475 **version)** to print.

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

479 TABLE 1. SOCIO-DEMOGRAPHIC CHARACTERISTICS AND CHEESE CONSUMPTION  
 480 HABITS OF PARTICIPANTS (DATA EXPRESSED AS NUMBER OF INDIVIDUALS AND, IN  
 481 BRACKETS, PERCENTAGE OVER THE WHOLE SAMPLE, (N=212).

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

*Subjective knowledge about cheese*<sup>a</sup>

Low knowledge (score $\leq 2$ )	41 (19.3)
Medium knowledge (score from 3 to 5)	164 (77.4)
High knowledge (score $\geq 6$ )	7 (3.3)

*Objective knowledge about cheese*<sup>b</sup>

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

482 <sup>a</sup> Answer scale ranged from 1 (low knowledge) to 7 (high knowledge).

483 <sup>b</sup> Grade from 0 to 100.

For Review Only



484 TABLE 2. MEAN AND STANDARD DEVIATION (SD), FOR THE SENSORY PARAMETERS EVALUATED BY THE  
 485 TRAINED PANEL AND FOR CONSUMERS' LIKING FOR THE CHEESES.

Cheese	Sensory parameters evaluated by the trained panel										Liking from consumers	
	Odor		Texture		Flavor		Persistence		OSQ		Mean	SD
	Mean	SD <sup>a</sup>	Mean	SD <sup>a</sup>	Mean	SD <sup>a</sup>	Mean	SD <sup>a</sup>	Mean	SD <sup>a</sup>	Mean	SD
1	3.2 cd	0.61	2.8 d	0.64	2.6 cd	0.53	2.5 c	0.53	2.7 e	0.50	5.2 e	1.98
2	2.3 d	1.14	3.9 abc	0.69	2.3 d	0.87	2.3 c	1.04	2.7 e	0.74	5.0 e	1.95
3	3.7 bcd	1.06	3.1 cd	0.35	3.6 bcd	0.77	3.7 abc	0.64	3.5 d	0.47	6.0 bcd	1.88
4	4.1 bcd	0.79	3.6 bcd	0.91	3.8 abc	1.08	3.8 ab	1.01	3.8 cd	0.82	5.7 d	1.55
5	4.3 abc	0.65	4.6 ab	0.53	3.4 bcd	0.92	3.4 bc	0.99	3.9 cd	0.64	6.2 bcd	1.56
6	4.3 abc	0.69	4.3 ab	0.49	4.1 ab	1.18	3.9 ab	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 ab	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

486 Within a column, different letters indicate significant differences between cheese samples ( $P < 0.05$ ) according to **Dunn's**  
 487 **test and** Tukey's HSD test.

488 <sup>a</sup> SD for trained panel was calculated as the mean score of SD of session 1 and SD of session 2.

489 TABLE 3. MEAN LIKING SCORES PER SAMPLE AND GROUP OF CONSUMERS CATEGORIZED  
 490 ACCORDING TO THEIR PEARSON CORRELATION COEFFICIENT ( $r$ ) BETWEEN OVERALL SENSORY  
 491 QUALITY (OSQ) AND INDIVIDUAL LIKING.

Cheese	Negative correlation between liking and OSQ			Positive correlation between liking and OSQ			
	High <sup>a</sup> and Medium <sup>b</sup>	Low <sup>c</sup>	Global	Low	Medium	High	Global
	Group 1 (n = 16)	Group 2 (n = 32)	Group 2 (n = 48)	Group 3 (n = 70)	Group 4 (n = 52)	Group 5 (n = 42)	Group 5 (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

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

493 <sup>a</sup>  $r \geq 0.7$

494 <sup>b</sup>  $0.4 \leq r < 0.7$

495 <sup>c</sup>  $r < 0.4$

Consumer number:

Date:

Hour:

Please, mark only one answer for each question:

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

<i>Cheese</i>	<i>Origin of the milk</i>		
Gouda	Cow <input type="checkbox"/>	Ewe <input type="checkbox"/>	I do not know <input type="checkbox"/>
Idiazabal	Cow <input type="checkbox"/>	Ewe <input type="checkbox"/>	I do not know <input type="checkbox"/>
Camembert	Cow <input type="checkbox"/>	Ewe <input type="checkbox"/>	I do not know <input type="checkbox"/>
Gorgonzola	Cow <input type="checkbox"/>	Ewe <input type="checkbox"/>	I do not know <input type="checkbox"/>
Manchego	Cow <input type="checkbox"/>	Ewe <input type="checkbox"/>	I do not know <input type="checkbox"/>

**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

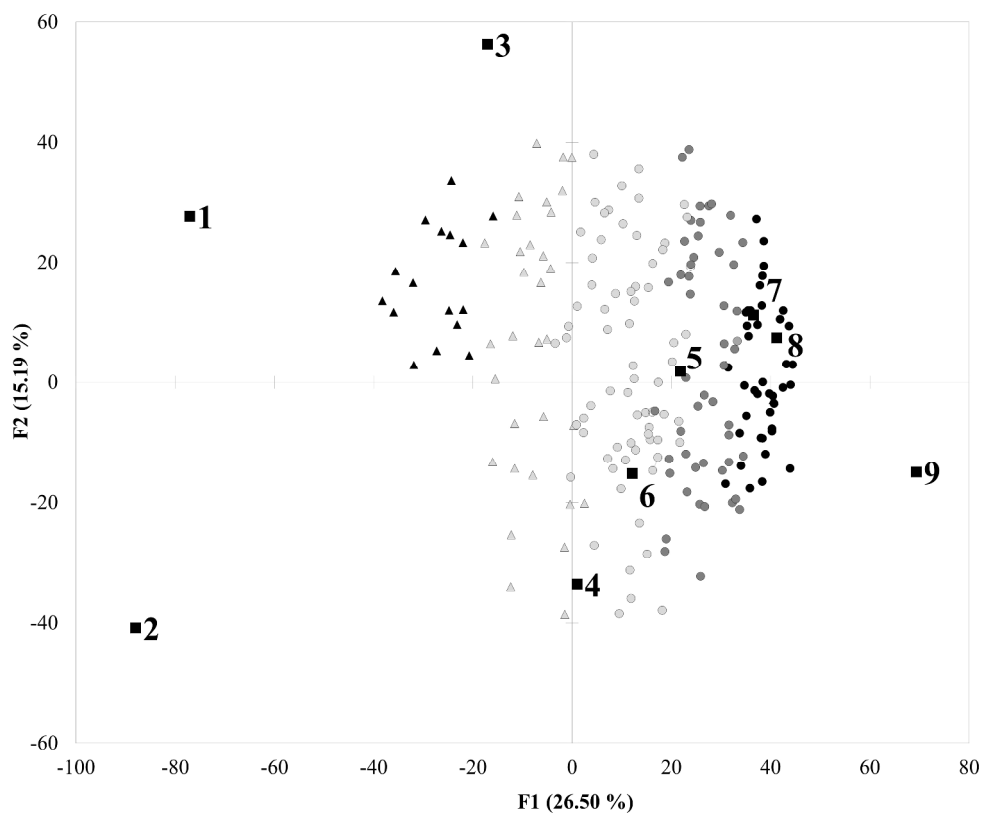


Figure 2. INTERNAL PREFERENCE MAPPING OF CONSUMERS' DATA (N = 212) WITH INDICATION OF THE LEVEL OF CORRELATION BETWEEN THE INDIVIDUAL LIKING AND THE OSQ FROM THE TRAINED PANEL: Consumer with negative correlation in triangles (in black = medium-high correlation; in light grey = low correlation) and consumers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

1009x869mm (96 x 96 DPI)

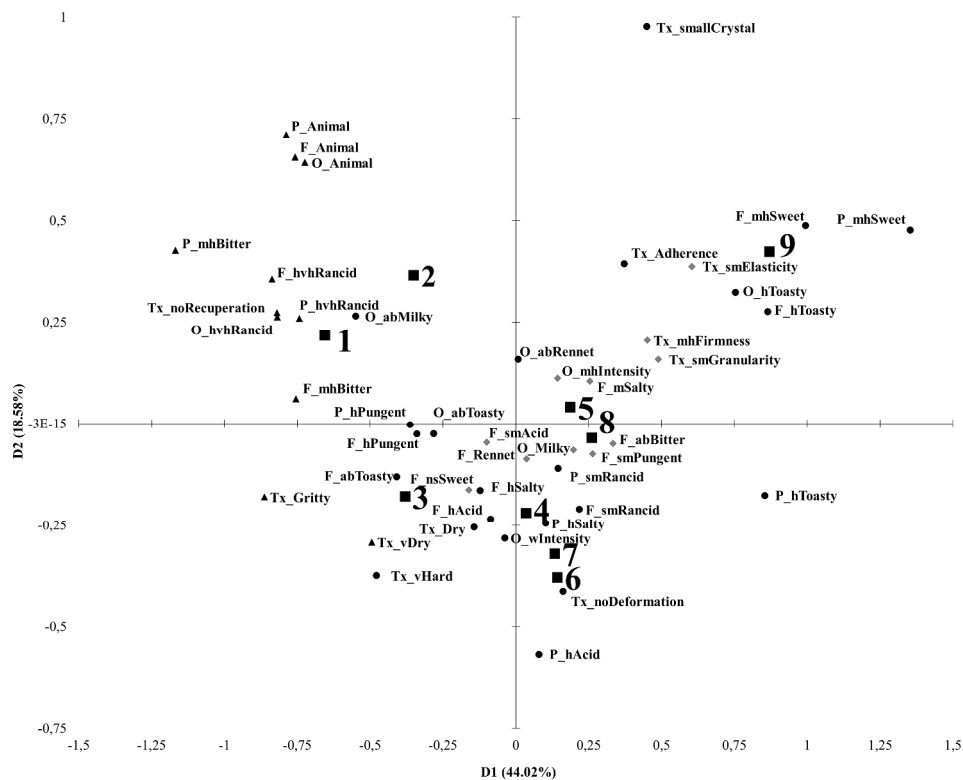


Figure 3. REPRESENTATION OF THE SIGNIFICANT ( $P < 0.05$ ) SENSORY CHARACTERISTICS FROM THE COCHRAN'S Q TEST AND THE CHEESE SAMPLES ( $N = 9$ ) OVER THE FIRST TWO COMPONENTS FROM THE SIMPLE CORRESPONDENCE ANALYSIS. Appropriate characteristics in rhombus, not totally appropriate characteristics in circles 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.

1009x869mm (96 x 96 DPI)

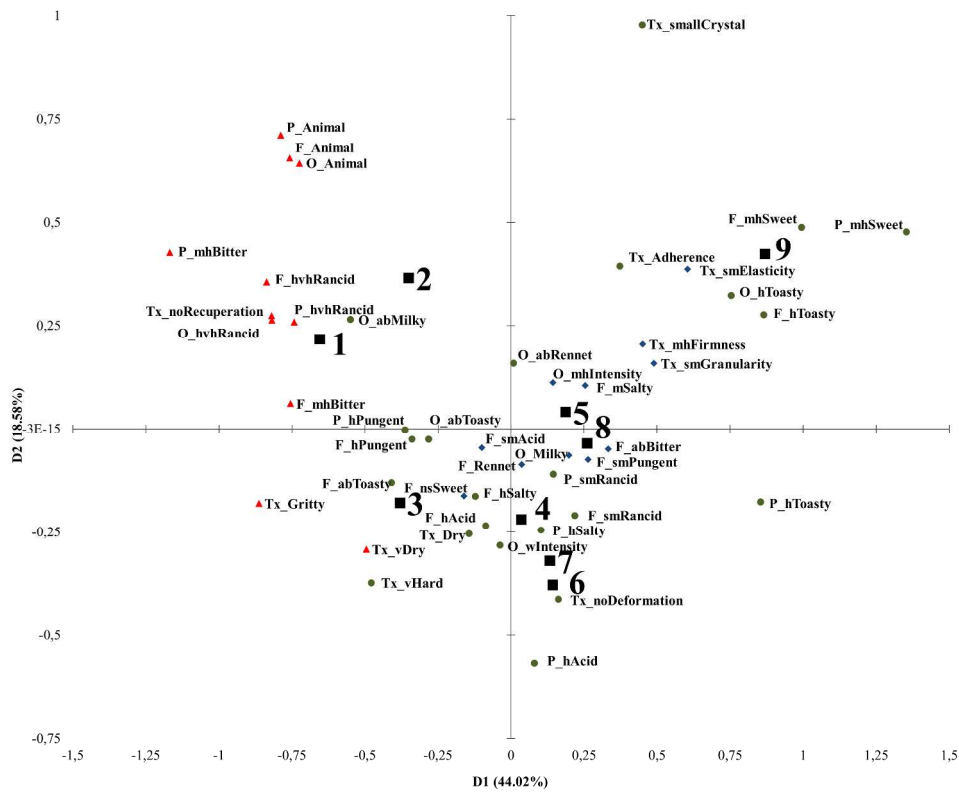


Figure 3. REPRESENTATION OF THE SIGNIFICANT ( $P < 0.05$ ) SENSORY CHARACTERISTICS FROM THE COCHRAN'S Q TEST AND THE CHEESE SAMPLES ( $N = 9$ ) OVER THE FIRST TWO COMPONENTS FROM THE SIMPLE CORRESPONDENCE ANALYSIS. Appropriate characteristics in rhombus, not totally appropriate characteristics in circles 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.

1009x869mm (96 x 96 DPI)

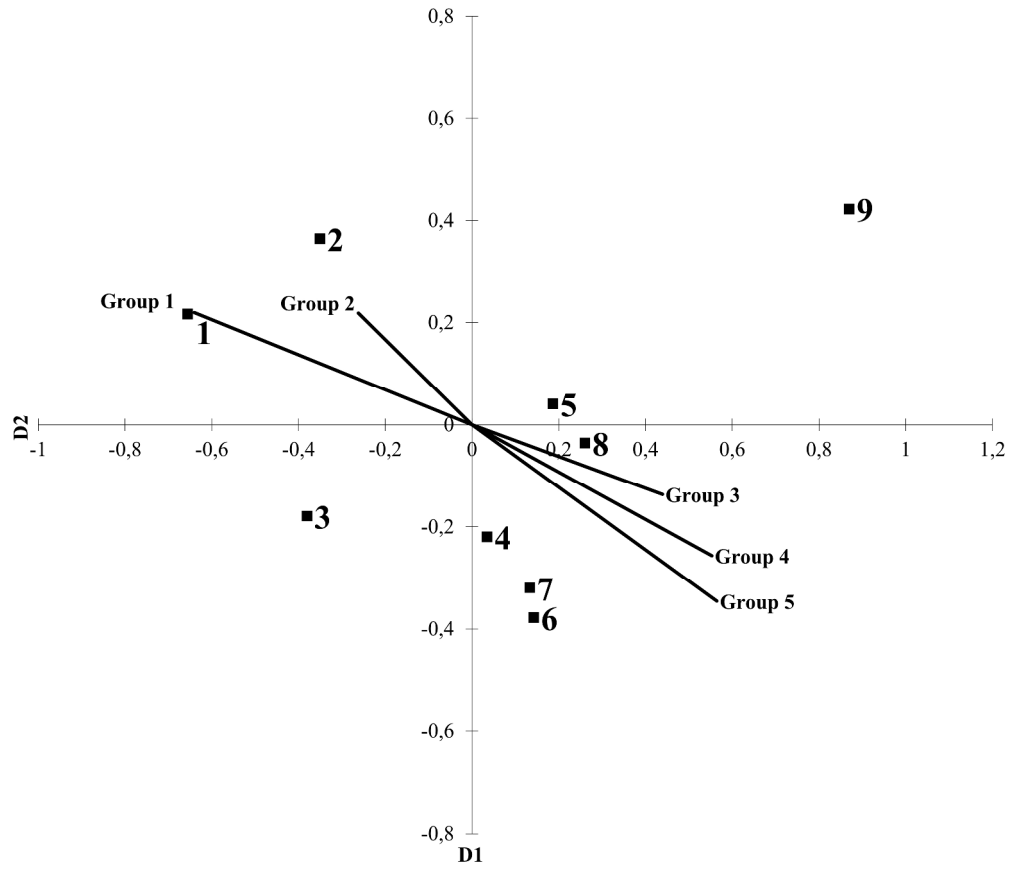


Figure 4. PREFERENCE MAPPING FROM THE SIMPLE CORRESPONDENCE ANALYSIS WITH REPRESENTATION OF CHEESE SAMPLES AND THE VECTOR OF MAXIMUM PREFERENCE FOR EACH OF THE FIVE GROUPS OF CONSUMERS IDENTIFIED.

1009x869mm (96 x 96 DPI)

