

# 1 **Effect of consumers' origin on perceived sensory quality, liking and liking** 2 **drivers: a cross-cultural study on European cheeses**

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## 20 **Abstract**

21 We aim at studying consumers' Perceived Sensory Quality (PSQ) concept. We manipulated a priori  
22 both familiarity (contrast local vs. foreign cheeses) and quality level (contrast PDO or traditional  
23 cheeses vs. their non-PDO and/or industrial counterpart). The study was run in four European  
24 countries. Thus, eight cheeses (one PDO or traditional cheese and one non-PDO cheese from each of  
25 the four European countries) were assessed by a total of 438 consumers (from 100 to 120 consumers  
26 from each region) in terms of PSQ and liking. The cheeses were also described by a trained panel.

27 PSQ depended on both consumers' and cheeses' origin. The main finding is that in the three countries  
28 with PDO culture, consumers identified domestic PDO cheese as having a significantly higher PSQ  
29 than its non-PDO counterpart, whereas they were not able to differentiate PDO and non-PDO cheeses  
30 from other countries. Overall, sensory drivers of PSQ were similar across consumers of different  
31 origin but, the relationship between PSQ and liking is higher for non-local cheeses than for local  
32 cheeses. Overall, the results support the idea that PSQ is related to liking but is also modulated by  
33 product familiarity.

#### 34 **Key words**

35 Perceived sensory quality, cross-cultural study, consumer, liking, PDO cheese.

#### 36 **1. Introduction**

37 According to Ophuis & Van Trijp (1995), consumers' perception of product quality results from a  
38 multidimensional perceptual process modulated by numerous factors extrinsic factors such as context,  
39 intrinsic product attributes or consumers' cultural background. Some studies related to product quality  
40 rely on liking assessments (Barnes, Bosworth, Bailey, & Curtis, 2014; Resano, San Juan, & Albisu,  
41 2012). Only in a few studies consumers are asked to assess perceived quality considering sensory  
42 characteristics or perceived sensory quality (PSQ). Most of these studies deal with the impact of  
43 extrinsic information on PSQ, mainly focused on aspects as price and origin (Veale & Quester, 2009a  
44 and 2009b; Bello Acebrón & Calvo Dopico, 2000) or sustainability labels (Samant & Seo, 2016).

45 The very scarce cross-cultural studies suggest that the impact of cultural background on PSQ  
46 judgments would be mediate by consumer's exposure and familiarity with the product (Sáenz-  
47 Navajas, Ballester, Pêcher, Peyron, & Valentin, 2013; Sáenz-Navajas, Ballester, Peyron, & Valentin,  
48 2014). These authors showed that Spanish consumers tended to find wines from La Rioja (Spain) as  
49 higher in quality than Côtes du Rhône (France) wines.

50 Products with PDO labels are linked to a specific geographical origin, some specific raw materials  
51 and traditional practices of production (Ballester, Dacremont, Le Fur, & Etiévant, 2005; Bertozzi,

52 1995) and the European regulation (OJEU, 2012) states that PDO products must specify the  
53 characteristics of the product, including sensory description.

54 The first hypothesis of the present study (H1) is that consumers from different European regions  
55 would assess differently PSQ of cheeses from different origins according to their familiarity towards  
56 the products. More specifically, they would be better at differentiating the quality level of PDO vs.  
57 non-PDO cheeses from their own country than for cheeses from other countries.

58 Concerning the relation between PSQ and liking by tasting the product, the literature is very scarce  
59 as well. In a study with 27 Californian Cabernet Sauvignon wines evaluated by consumers and by  
60 wine experts, Hopfer & Heymann (2014) found a high correlation between liking and PSQ, although  
61 for some consumers liking and perceived quality was not at all correlated to the quality scores as  
62 stated by the experts. The authors concluded that experts based more their evaluations on objective,  
63 descriptive attributes, while consumers were less able to do so.

64 Our second hypothesis (H2) is that PSQ is largely related to liking, but this relation would be weaker  
65 when consumers are most familiar with the product.

66 In fact, going beyond the analytical evaluation of quality by experts, the sensory characteristics  
67 driving the PSQ for consumers would be related to the familiarity with the product. In this sense, the  
68 third hypothesis (H3) is that sensory drivers of PSQ are likely culture-dependent, so they would differ  
69 according to consumers' origin.

70 To sum up, the objective of the present work is to gain a better understanding of consumers' PSQ by  
71 testing the three previously mentioned hypothesis, tackling the issue of familiarity as modulator of  
72 product perception. To address this issue, four PDO or traditional cheeses from four European regions  
73 (PDO Parmigiano Reggiano, PDO Idiazabal, PDO Comté and Turunmaa traditional cheese) and one  
74 similar industrial cheese from each of these regions were evaluated by consumers from the four  
75 regions. All eight cheeses were assessed by the four consumer groups for liking and PSQ. In order to  
76 identify the sensory drivers of PSQ the cheeses were also described by a trained panel.

77

78 **2. Materials and methods**

79 **2.1. Sample selection and preparation**

80 Eight hard and semi-hard cheese samples from four European countries (Finland, France, Italy and  
81 Spain) were used in the experiment (Table 1). Three of them were PDO cheeses: Comté, Parmigiano-  
82 Reggiano and Idiazabal. As Finnish PDO cheeses do not exist, a traditional one was chosen  
83 (Turunmaa style cheese) and was considered as an equivalent of PDO product for the purposes of this  
84 study. The other four cheeses were selected from each of the four regions and were similar in terms  
85 of sensory characteristics to their counterpart PDO cheese. A representative cheese of each PDO was  
86 chosen and all the units of each cheese came from the same batch.

87 Each of the four laboratories participating in the study collected the two cheeses from its region one  
88 month prior to their evaluation. They were vacuum-sealed and sent to the other laboratories in an  
89 isothermal container with cold accumulators. Once at the laboratory, the samples were placed in a  
90 refrigerator at  $5 \pm 3$  °C. The night before analysis, the plastic film was removed and samples were  
91 kept in a cellar at  $17 \pm 2$  °C. One hour before their evaluation, cheeses were sliced into pieces of 1.7  
92 x 1.7 x 3.0 cm, placed in a lunch box and stored in the cellar. At the time of the test, samples were  
93 served to participants (trained assessors or consumers) at  $19 \pm 2$  °C in plastic trays.

94

95 Table 1. Description of the cheeses used in the study.

96

<b>Cheese origin</b>	<b>Product (Cheese) / Appellation</b>	<b>Milk origin</b>	<b>Type of paste</b>	<b>Code</b>
Finland	Turunmaa / Traditional	Pasteurized cow's milk	Uncooked semi-hard	TRA TU
Finland	Emmental / non-PDO	Pasteurized cow's milk	Cooked semi-hard	nPDO EM-FI
France	Comté / PDO	Raw cow's milk	Cooked semi-hard	PDO CO
France	Emmental / non-PDO	Pasteurized cow's milk	Cooked semi-hard	nPDO EM-FR
Italy	Parmigiano-Reggiano / PDO	Raw cow's milk	Cooked hard	PDO PR
Italy	Hard cheese / non-PDO	Pasteurized cow's milk	Cooked hard	nPDO HCh-IT
Spain	Idiazabal / PDO	Raw ewe's milk	Uncooked hard	PDO ID
Spain	Hard cheese / non-PDO	Pasteurized ewe's milk	Uncooked hard	nPDO HCh-SP

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101 **2.2. Assessment of liking and PSQ**

102 **2.2.1. Consumers**

103 A total of 438 consumers from four European cities participated in this research (Table 2).

104 Table 2. Socio-demographic aspects and cheese consumption frequency of consumers (data expressed  
105 as number of participants and as percentage (in brackets)).

	Jokioinen- Helsinki(JH) (Finland) n = 109	Dijon (DI) (France) n = 101	Reggio Emilia (RE) (Italy) n = 120	Vitoria-Gasteiz (VG) (Spain) n = 108
<i>Gender</i>				
Male	36 (33.0)	50 (49.5)	59 (49.2)	54 (50.0)
Female	72 (66.1)	51 (50.5)	60 (50.0)	54 (50.0)
No answer	1 (0.9)	0 (0.0)	1 (0.8)	0 (0.0)
<i>Age range (years)</i>				
18 - 30	19 (17.4)	49 (48.5)	36( 30.0)	34 (31.5)
31 - 45	44 (40.4)	23 (22.8)	36 (30.0)	40 (37.0)
> 45	46 (42.2)	29 (28.7)	46 (38.3)	34 (31.5)
No answer	0 (0.0)	0 (0.0)	2 (1.7)	0 (0.0)
<i>Level of studies completed</i>				
Secondary	40 (36.7)	23 (22.8)	48 (40.0)	33 (30.6)
Superior	69 (63.3)	78 (77.2)	69 (57.5)	73 (67.6)
No answer	0 (0.0)	0 (0.0)	3 (2.5)	2 (1.8)
<i>Frequency of cheese consumption</i>				
Daily or almost daily	73 (67.0)	56 (55.4)	44 (36.7)	40 (37.0)
Several times a week	24 (22.0)	37 (36.6)	53 (44.2)	47 (43.5)
Once a week	6 (5.5)	7 (6.9)	16 (13.3)	17 (15.7)
A few times a month	6 (5.5)	1 (1.1)	5 (4.2)	4 (3.8)
No answer	0 (0.0)	0 (0.0)	2 (1.6)	0 (0.0)

106

107 They were recruited from previous databases and by using different media (radio, e-mails, social  
108 networking sites and posters on the campus or in the research centre). Consumers knew they were  
109 going to participate in a cheese consumer test and signed an informed consent voluntarily. Cheeses  
110 were commercial cheeses, that is, their sale and consumption were authorized, so it was assumed that  
111 they do not present a health risk. Consumers' personal data were treated and managed according to  
112 the European regulation (EU) 2016/679 on the protection of natural persons with regard to the  
113 processing of personal data and on the free movement of such data. Consumers who expressed their  
114 willingness to participate were asked about gender, age, level of completed studies and cheese  
115 consumption frequency. Only consumers who declared to consume cheese more than once per month

116 were recruited. A balanced distribution across gender, age ranges (18-30, 31-45, > 45) and level of  
117 studies completed (secondary or superior) was established. As shown in Table 2, most consumers  
118 from the four cities eat cheese at least once a week. Finnish consumers reported the highest  
119 consumption frequency.

### 120 **2.2.2. Experimental design**

121 The eight cheeses (Table 1) were tested by all the consumers. No information about the aim of the  
122 study was provided to the consumers (they only knew that they were participating in a “cheese  
123 study”). The experimental protocol was initially written in English and translated into Finnish,  
124 French, Italian and Spanish. Translation from English to the local language was made by  
125 professionals of each laboratory in order to be the instructions and terminology easy and clearly  
126 understandable by the local participants. In addition, several members of each laboratory supervised  
127 the translation. Before developing the test, a pre-test was carried out in each laboratory to find out  
128 possible difficulties of the test (duration of the test, possible fatigue because of the number of samples  
129 ...) and to observe whether the participants understood the test instructions. No difficulties related to  
130 terminology were found in the pre-test in any laboratory.

131 The experiment was carried out proceeding in the same manner in the four cities. The sessions were  
132 distributed in two stages: first a liking test and then a perceived sensory quality categorization test. A  
133 rest time of 10 minutes was established between stages. The number of sessions varied between six  
134 and ten depending on the capacity of the laboratories. To complete the whole session took around 45  
135 minutes. For the liking test, consumers were asked to score the eight samples on a 10 cm line scale  
136 from 0-“I don’t like it at all” to 10-“I like it very much”. For the PSQ categorization test, consumers  
137 had to evaluate the cheeses and sort them according to their global sensory quality perception into  
138 five categories: “very high” (5), “high” (4), “medium” (3), “low” (2) or “very low” (1) quality. In  
139 both tests consumers were allowed to taste the cheeses as many times as they wanted, although they  
140 were advised not to test the same sample too many times to avoid fatigue. Consumers were free to re-

141 taste a cheese sample when needed, but were advised not to re-taste the same sample more times to  
142 avoid sensory fatigue. For both tests, consumers were instructed to wait 30 seconds between samples  
143 and to chew a piece of apple and rinse their mouth with water to eliminate any residual product.  
144 Sample codes were different in each test. Samples were codified with three digits and presented  
145 according to a Williams Latin square design established by FIZZ software 2.40H (Biosystemes,  
146 Couternon, France) so the sample order for each participant was random and presentation order  
147 associated bias was avoided. Also, sample codes of each sample were different in the two tests.  
148 Data were collected on paper forms designed by using FIZZ software 2.40H. Upon completing the  
149 session, participants received a gift for their participation.

## 150 **2.3. Descriptive sensory analysis**

### 151 **2.3.1. Assessors**

152 The descriptive analysis of the eight cheese samples was carried out in Vitoria-Gasteiz, in the Sensory  
153 Laboratory of the University of the Basque Country (LASEHU). Sixteen assessors (five males and  
154 11 females; age range 34-68 with average age 45) were selected taking into account their training  
155 level in descriptive analysis: six expert assessors of the official panel for sensory quality control of  
156 PDO Idiazabal cheese and ten assessors with great experience in descriptive sensory analysis of foods  
157 (the majority of them with experience in cheese evaluation).

### 158 **2.3.2. Experimental design**

159 Six two hours sessions were carried out:

160 - *Term generation, selection of terms and the score card design.* Two sessions were held to develop  
161 the attribute list. Only the six expert assessors took part in the first session. A list of sensory  
162 descriptors (aroma, taste and trigeminal sensations) was previously prepared from the list published  
163 by Berodier *et al.* (1997) and presented to the participants. To facilitate the term generation, cheeses  
164 were compared in pairs: PDO cheese vs. non-PDO cheese from the same region. In this way, assessors  
165 had to indicate perceived sensations (terms) and their intensity (low, medium or high) for each  
166 sample. Then, they had to compare the two samples and mark if there were differences in intensity for

167 each of the perceived sensations, or not. The second session was attended by all the assessors. Based  
168 on the terms collected through the first session, a second list including exclusively aroma terms was  
169 provided. The procedure followed with these samples was the same as in the first session.

170 The selection of terms and the score card design were carried out using results obtained in the previous  
171 sessions. As far as aroma was concerned, only terms with a citation frequency (CF; percentage of  
172 times that each term was cited for each sample over the total number of times that could be cited)  $\geq$   
173 20% or with a CF  $<$  20% but with a CF  $\geq$  40% for any of the samples in the second session were  
174 selected. A similar criterion was applied by Campo, Ballester, Langlois, Dacremont, & Valentin  
175 (2010) in a study of Burgundy Pinot Noir wines. The terms selected were: fresh butter, boiled milk,  
176 acidified milk, fresh vegetable, boiled vegetable, nut, caramel, burnt, leather, meat soup, rennet and  
177 butyric acid.

178 With regard to taste, the terms used in the first session (sweet, acid, salty, bitter and pungent) were  
179 directly included in the final list. Based on Lavanchy *et al.* (1999), texture terms selected were  
180 firmness, friability, solubility, adherence and humidity in mouth.

181 A definition of each term was established, as well as the evaluation procedure. Continuous linear 10  
182 cm scales (anchored at points 0 and 10 and with an additional cm at each end) were used for attribute  
183 intensity scoring.

184 - *selection of references and training.* Assessors were provided with references for taste, aroma and  
185 texture, either chemical substances or commercial products. References were prepared according to  
186 Berodier *et al.* (1997), Lavanchy *et al.* (1999), Pérez-Elortondo *et al.* (2007) and Ojeda *et al.* (2015)  
187 procedures. References were prepared with a cheese base for their perception to be as close as possible  
188 to the real situation of cheese evaluation.

189 - *Analysis of the samples of the study.* The eight samples were evaluated in triplicate over three  
190 sessions. These session took place in the two weeks following the consumers study. A dummy sample  
191 was first evaluated in individual booths and then a group discussion took place for a last scoring  
192 alignment. Then, panellists scored the eight samples in booth using Fizz software 2.40H. Samples



193 were coded with three digits random numbers and presented according to a Williams Latin square  
194 design. Panellists were instructed to wait 20 seconds between each sample and to chew a piece of  
195 apple and rinse their mouth with water to eliminate any residual product. A five minutes break was  
196 programmed between the first four and the remaining four samples.

## 197 **2.4. Data Analysis**

### 198 **2.4.1. Effect of consumer origin, cheese origin and PDO/non-PDO on PSQ (H1)**

199 A four-way mixed ANOVA was performed on PSQ scores according to the following model:

$$200 Y = \mu + \text{consumer origin} + \text{cheese origin} + \text{PDO/non-PDO} + \text{consumer}(\text{consumer origin}) + \text{cheese} \\ 201 \text{origin*consumer}(\text{consumer origin}) + \text{cheese origin*consumer origin} + \text{cheese origin*PDO/non-PDO} \\ 202 + \text{consumer}(\text{consumer origin})*\text{PDO/non-PDO} + \text{consumer origin*PDO/non-PDO} + \text{cheese} \\ 203 \text{origin*consumer origin* PDO/non-PDO} + \textit{error}$$

204 In this model, cheese origin, consumer origin, and PDO/non-PDO were considered as fixed factors  
205 and consumer as random factor. A Tukey's honest significant difference (HSD) post hoc test was  
206 applied to consumer origin to find significant ( $p < 0.05$ ) differences between pair of samples.

207 For first order interaction cheese origin\*consumer origin, Kruskal-Wallis test was applied ( $p < 0.05$ )  
208 on PSQ scores in each consumer origin. Dunn's test (with Bonferroni's correction) was run on  
209 consumer origin to find significant differences ( $p < 0.05$ ) between pairs of samples. Also, paired t-  
210 tests with Bonferroni's correction (for 16 comparisons from two effects at 5% significance level,  
211 significant differences at  $p < 0.003$ ) were run on PSQ between local and non-local cheeses in each  
212 consumer origin.

213 Regarding first order interaction consumer origin\*PDO/non PDO, paired t-test with Bonferroni's  
214 correction (for eight comparisons from two effects at 5% significance level, significant differences at  
215  $p < 0.006$ ) was applied for calculating significant differences in PSQ according to PDO/non-PDO in  
216 each consumer origin.

217 Finally, with regard to second order interaction cheese origin\*consumer origin\*PDO/non-PDO,  
218 paired t-test with Bonferroni's correction (for eight comparisons from two effects at 5% level,

219 significant differences at  $p < 0.006$ ) was applied in order to study significance differences in PSQ  
220 between local and non-local PDO and non-PDO cheeses in each consumer origin.

221 Kruskal-Wallis test was run with XLSTAT 2011 (Addinsoft, Paris, France). The other statistical  
222 analyses were computed using IBM® SPSS® Statistics25 (SPSS Inc., Chicago, USA) with the  
223 exception of Bonferroni's correction from paired t-test, which was calculated without using statistical  
224 software (significant differences at  $p < (5\% \text{ significance level} / \text{number of comparisons})$ ).

#### 225 **2.4.2. Relationship between PSQ and liking (H2)**

226 Spearman's correlation coefficient ( $r$ ) between PSQ and liking scores were calculated on individual  
227 scores considered all together.

228 Then, for each consumer origin, a correlation coefficient between PSQ and liking scores was  
229 calculated for the eight cheeses considered together, for PDO cheeses, for non-PDO cheeses and for  
230 each cheese individually.

231 Correlation coefficient ( $r \geq 0.7$ ) was considered as a high correlation,  $0.4 \leq r < 0.7$  medium correlation  
232 and  $r < 0.4$  low correlation.

233 Analyses were computed with IBM® SPSS® Statistics25.

#### 234 **2.4.3. Sensory drivers of PSQ (H3)**

235 A three-way ANOVA was performed on sensory scores from the trained panel, with product, assessor  
236 and session as fixed factors considering all first-order interactions. Further, a PCA was performed on  
237 the mean scores of discriminant attributes. Mean scores of consumers' PSQ from each city were  
238 added as supplementary variables. Finally, Hierarchical Cluster Analysis (HCA) was done using  
239 Squared Euclidean distances and Ward's criterion. In this analysis, all the dimensions resulting from  
240 PCA were considered.

241 ANOVA was performed using IBM® SPSS® Statistics 25 while PCA and HCA were done using  
242 XLSTAT 2011.

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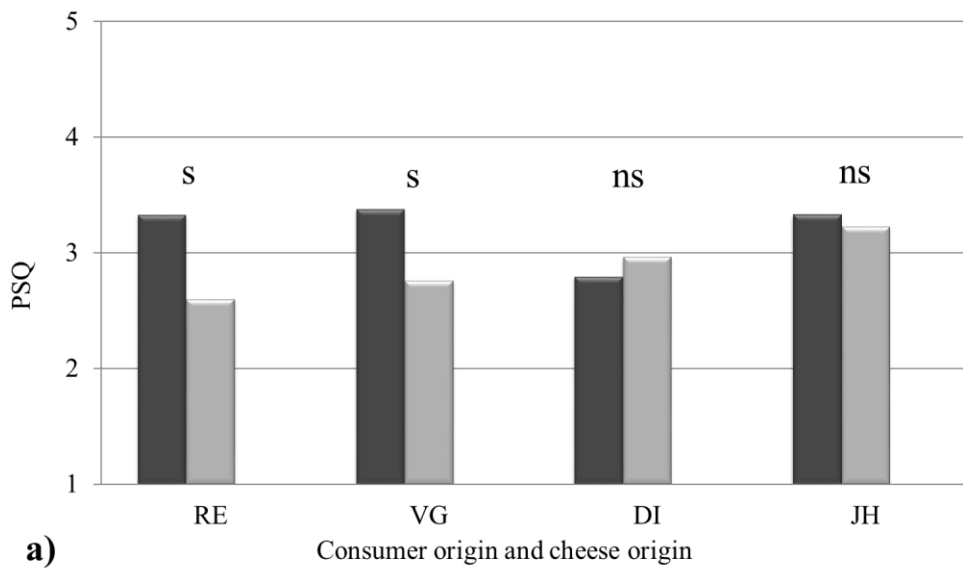
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245 **3. Results**

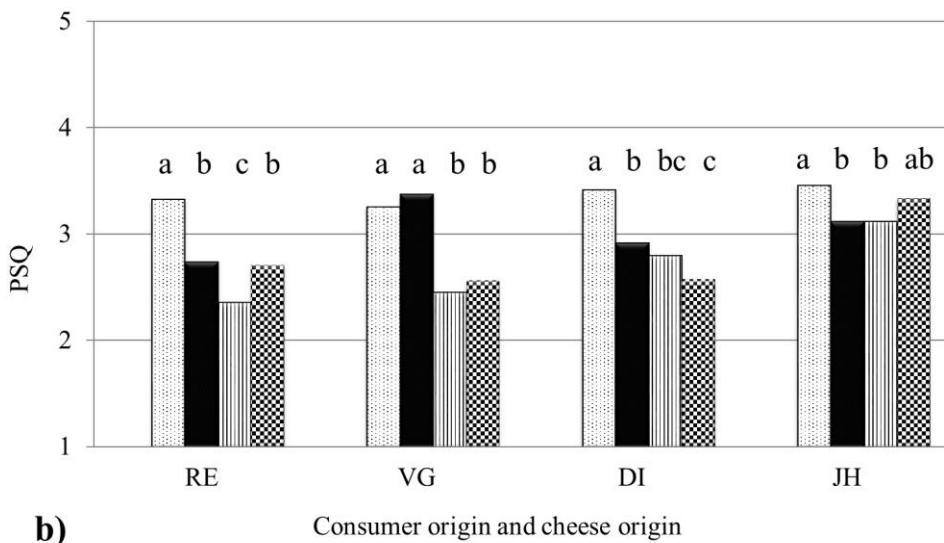
246 **3.1. Effect of consumer origin, cheese origin and PDO/non-PDO on PSQ (H1)**

247 The four-ways mixed ANOVA showed that PSQ depends on: consumer origin ( $F(3, 434) = 22.4$ ,  
 248  $p < 0.001$ ), cheese origin ( $F(3, 1302) = 63.7$ ,  $p < 0.001$ ) and PDO/non-PDO ( $F(1, 434) = 156.6$ ,  $p <$   
 249  $0.001$ ).

251 *Figure 1. PSQ in each consumer origin according to cheese origin.*



253 **a)**  
 254 *Dark and light grey bars represent local and non-local cheeses, respectively. Signification of differences from paired t-*  
 255 *test (with Bonferroni's correction): s when significant ( $p < 0.003$ ) and ns when non-significant ( $p \geq 0.003$ ).*



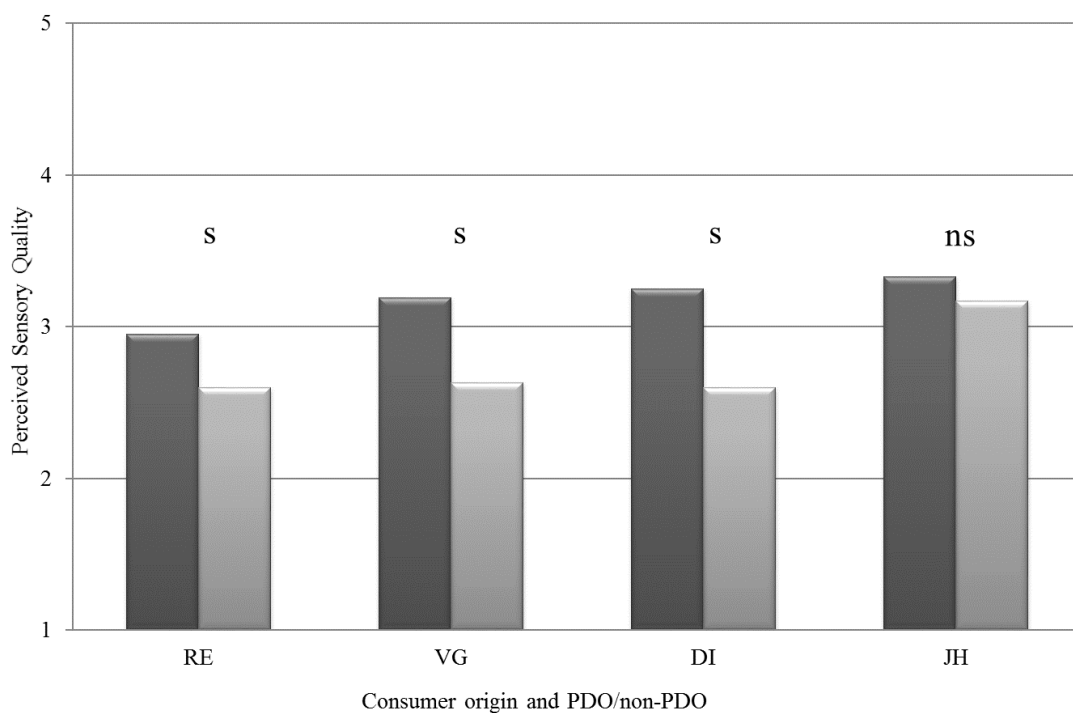
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260 Regarding consumer origin, RE consumers gave significantly ( $p < 0.05$ ) lower scores (mean score,  
 261 MS 2.77, standard error, SE 0.036) than consumers from the other three cities and JH consumers gave  
 262 significant ( $p < 0.05$ ) higher scores (MS 3.25, SE 0.037) than the consumers from the other three  
 263 cities. Significant differences were not found between consumers from VG (MS 2.91, SE 0.039) and  
 264 DI (MS 2.92, SE 0.042).

265 In RE and VG, local cheeses were scored higher than non-local cheeses (Figure 1a). A significant  
 266 cheese origin\*consumer origin interaction ( $F(9, 1303) = 10.1, p < 0.001$ ) confirmed that quality  
 267 perception among consumers from different origins depends on cheese origin (Figure 1b). Kruskal-  
 268 Wallis test revealed significant differences among products in each consumers' origin. Particularly,  
 269 in RE the most positively evaluated samples were Italian cheeses and in VG local cheeses together  
 270 with Italian cheeses. By contrast, consumers in DI and JH did not find significant PSQ differences  
 271 between local and non-local cheeses. In fact, Italian cheeses got the highest score in DI and JH (in  
 272 this last city with local cheeses as well).

273

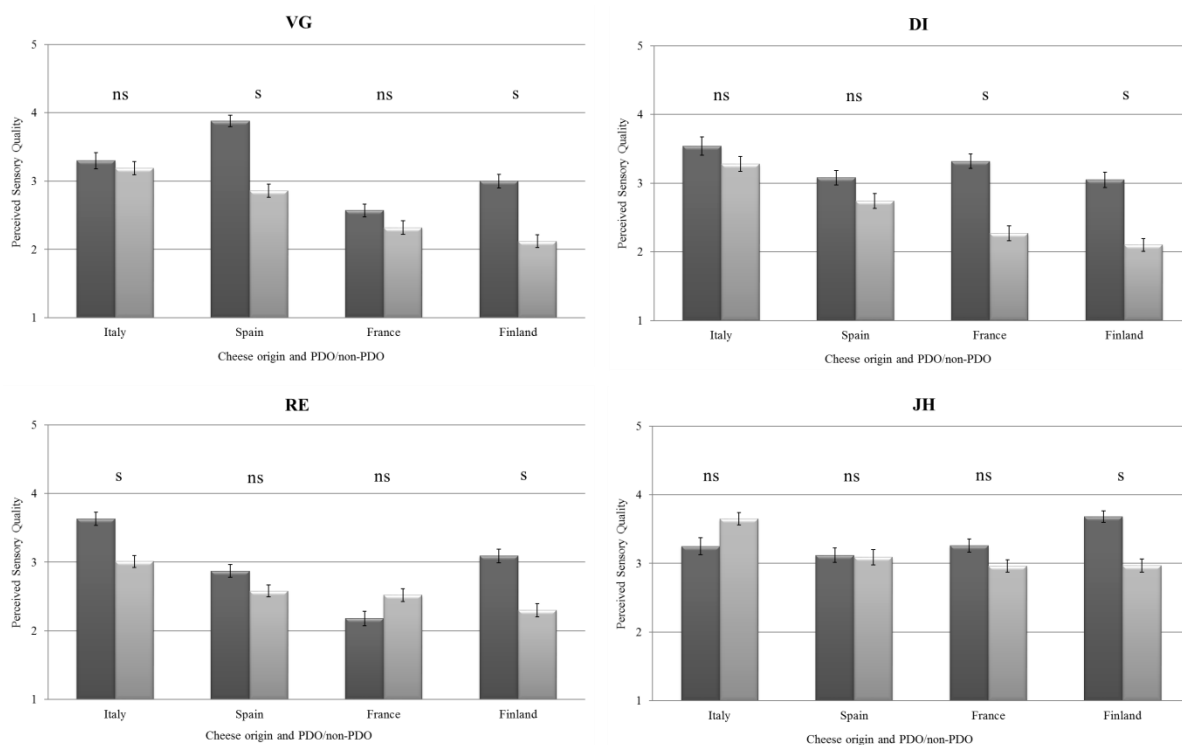


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Figure 2. PSQ in each consumer origin according to PDO/non-PDO.

Dark and light grey bars represent PDO and non-PDO cheeses, respectively. Signification of differences from paired t-test (with Bonferroni's correction): s when significant ( $p < 0.006$ ) and ns when non-significant ( $p \geq 0.006$ ).

280 As hypothesized, PDO cheeses, all together, were perceived as significantly higher in quality than  
 281 non-PDO cheeses (MS 3.17, SE 0.028 vs MS 2.75, SE 0.026, respectively).  
 282 The significant interaction between PDO/non-PDO and consumer origin ( $F(3, 434) = 10.3, p < 0.001$ )  
 283 indicated that the different sensory quality perception for PDO and non-PDO products depends, to a  
 284 certain extent, on consumers' origin. Actually, significant differences were found between PDO and  
 285 non-PDO cheeses in RE, VG and DI, where PDO cheeses were scored higher in PSQ than non-PDO  
 286 cheeses whereas, no significant differences were found in JH (Figure 2).



287  
 288  
 289 *Figure 3. PSQ in each consumer origin according to cheese origin and PDO/non-PDO.*  
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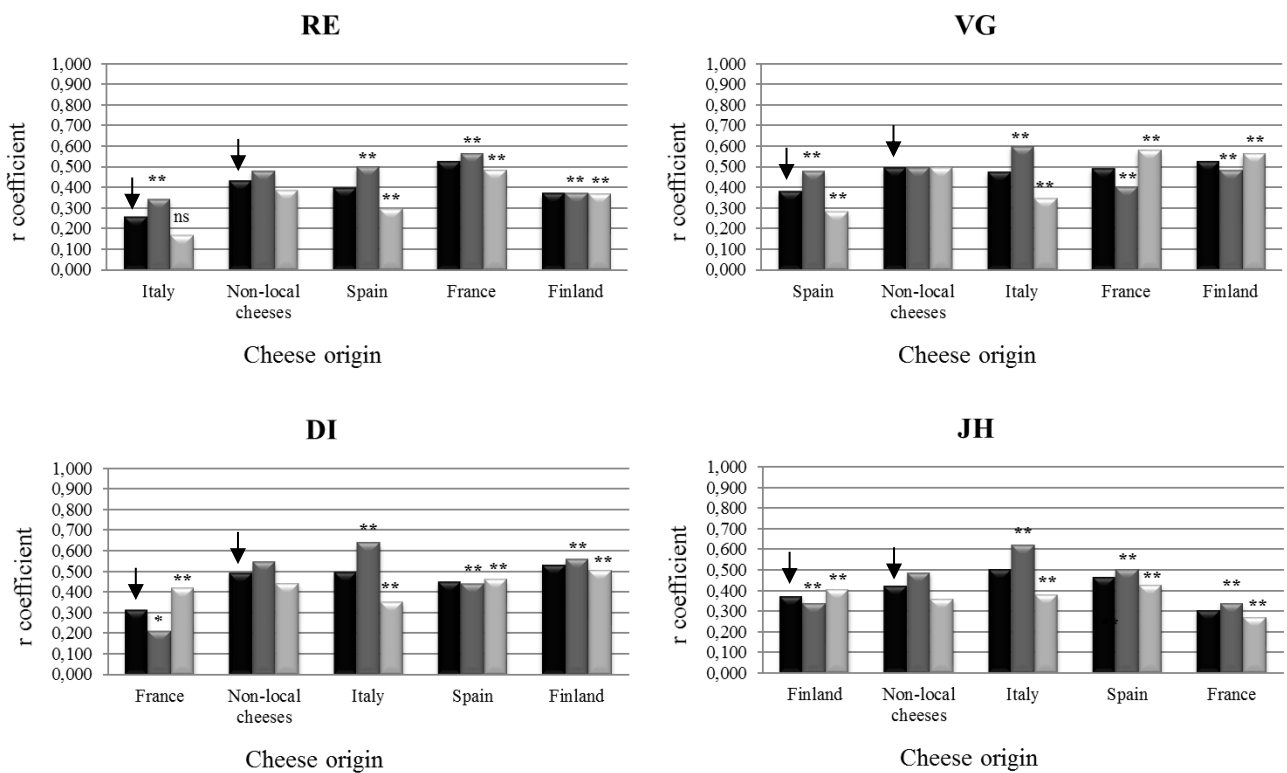
291 *Dark and light grey bars represent PDO and non-PDO cheeses, respectively. Significance of differences from paired t-*  
 292 *test (with Bonferroni's correction): s when significant ( $p < 0.006$ ) and ns when non-significant ( $p \geq 0.006$ ).*  
 293

294 Figure 3 illustrates the significant second-order consumers' origin\*cheese origin\*PDO/non PDO  
 295 interaction ( $F(9, 1301) = 11.1, p < 0.001$ ). In VG, DI and RE, significant differences between local  
 296 PDO and local non-PDO cheeses were found whereas no difference between PDO and non PDO  
 297 cheese is perceived for foreign cheeses. There is an exception for Finnish cheeses with the traditional  
 298 cheese scored significantly higher in PSQ than its industrial counterpart in every city.  
 299

300 **3.2. Relationship between PSQ and liking (H2)**

301 A significant correlation was observed between PSQ and liking scores given by all consumers to the  
 302 eight cheeses considered all together ( $r = 0.508, p < 0.001$ ). In each city, a significant ( $p < 0.05$ )  
 303 correlation between PSQ and liking was obtained both for PDO and for non-PDO cheeses from each  
 304 cheese origin, with the exception of local non-PDO cheese in RE (Figure 4). Also, a higher correlation  
 305 was observed for non-local cheeses than local cheeses in RE, VG and DI. In the case of JH this  
 306 difference was not so clear.

307



308  
 309 *Figure 4. Correlation coefficients (r) between PSQ and liking in each city for local and non-local cheeses (considered*  
 310 *separately and together as averaged r value).*

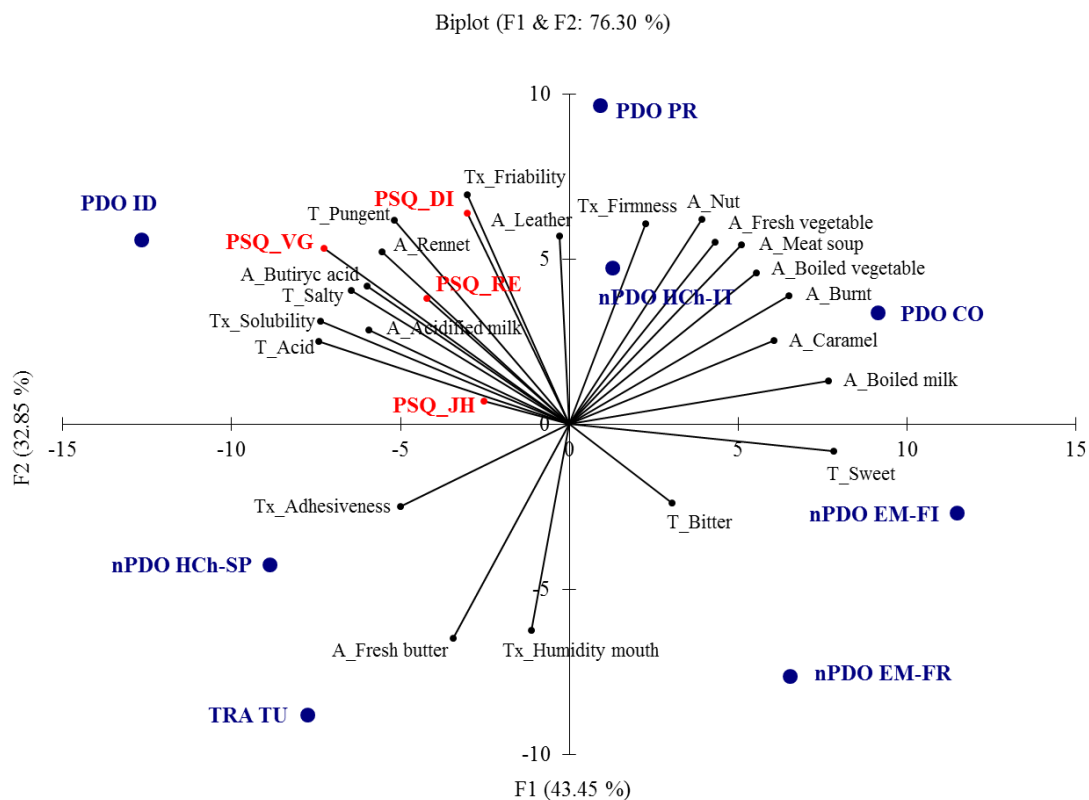
313 *Black bars represent the average of PDO and non-PDO cheeses, dark and light grey bars represent PDO and non-PDO*  
 314 *cheeses, respectively. ns: no significant correlation ( $p \geq 0.05$ ); \*:  $p < 0.05$ ; \*\*:  $p < 0.01$ .*

315

316 **3.3. Sensory drivers of PSQ (H3)**

317 The results of the three-way ANOVA on descriptive scores revealed significant ( $F(154, 1278) = 16.7$ )  
 318  $p < 0.001$ ) differences among products for all attributes.

319 Figure 5 shows the loading plot and the product map of PCA run on all descriptive attributes, with  
 320 mean scores of PSQ from consumers of each city as supplementary variables. The first two  
 321 principal components explained 76.30% of the total variance and cheeses are distributed in the four  
 322 quadrants of the plot. PC1 is a taste factor opposing “sweet” to “acid” and PC2 is a texture axis  
 323 opposing “friability” and “firmness” to “humidity mouth”.

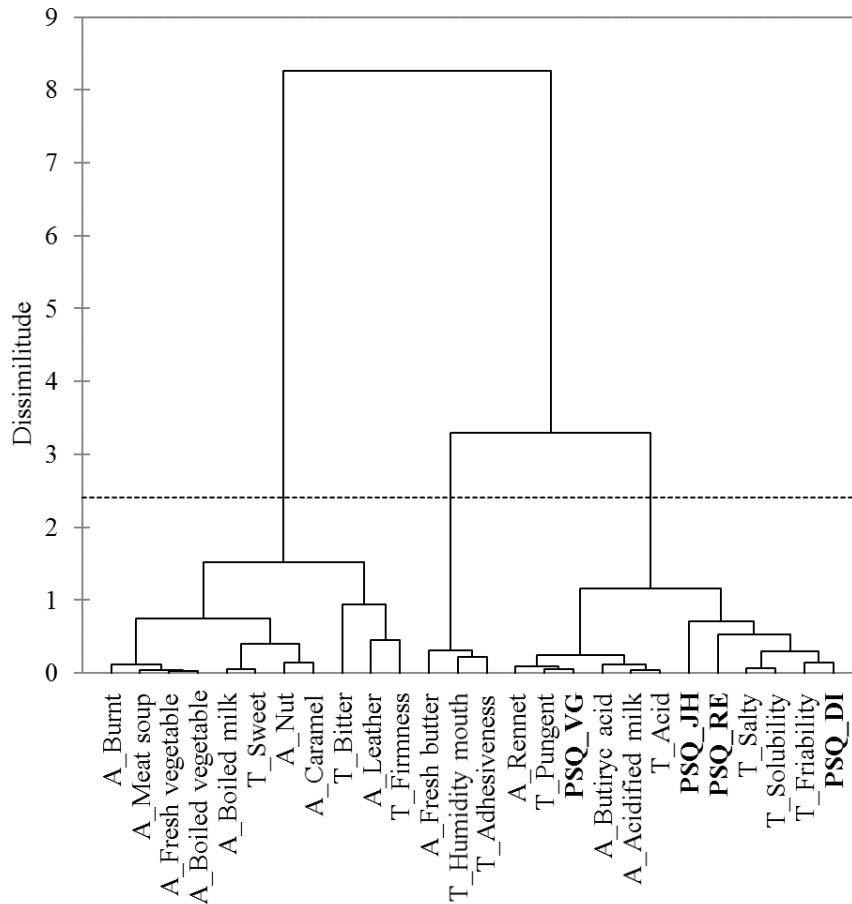


325  
 326  
 327 *Figure 5. Representation of cheeses, sensory characteristics and consumers' PSQ over the first two components by*  
 328 *PCA.*

329  
 330 *A= aroma; T= taste; Tx= texture.*

331  
 332 PSQ for consumers from VG was driven mainly by “strong” sensory attributes, as “butyric acid”,  
 333 “rennet”, “acidified milk”, “acid” and “pungent”, whereas PSQ of consumers from RE and DI was  
 334 driven by “salty”, “solubility” and “friability”. Finland showed a lower tendency toward these last  
 335 sensory characteristic. However, PSQ for each consumer origin was represented in the same  
 336 quadrant of the PCA suggesting that there are no marked differences in the drivers explaining PSQ

337 among the four cities In fact, when HCA was run to identify clusters of drivers of PSQ, three main  
 338 clusters were identified (Figure 6) and four PSQ were included in the same cluster.  
 339



340  
 341  
 342  
 343 *Figure 6. Hierarchical Cluster Analysis. Clusters of drivers of PSQ for the different consumer origin.*  
 344  
 345 *A= aroma; T= taste; Tx= texture.*  
 346

347 **4. Discussion**

348 The main objective of this work was to study the impact of consumers’ origin on Perceived Sensory  
 349 Quality of cheeses according to their familiarity with cheeses. We first hypothesized (H1) that  
 350 consumers from different European regions would assess differently PSQ of cheeses from different  
 351 origins. Consumers gave higher scores to domestic cheeses in two (RE and VG) of the four cities.  
 352 More interestingly, we found that consumers were better at discriminating between the local higher  
 353 quality cheese (PDO) and the local lower quality cheese (non-PDO). This is obvious for consumers



354 from Italy (RE), Spain (VG) and France (DI) who were the only ones to identify PDO cheese from  
355 their own region as higher in PSQ than the non-PDO counterpart.

356 According to their familiarity towards the products and, more specifically, they would be better at  
357 differentiating the quality level of PDO vs. non-PDO cheeses from their own country than for cheeses  
358 from other countries. They scored PDO local cheese significantly higher in PSQ compared to the non-  
359 PDO whereas they did not perceive any differences between PDO vs. non PDO for foreign products.  
360 This is interpreted in terms of familiarity with the products, although we did not directly measure  
361 cheese familiarity, as people are more exposed to local vs. non-local cheeses. This is in line with  
362 Sáenz-Navajas, Ballester, Peyron, & Valentin (2014) who pointed out that consumers tend to  
363 categorize local wines as higher in quality than non-local ones. In another study (Sáenz-Navajas,  
364 Ballester, Peyron, & Valentin, 2013) those authors found that Spanish consumers from La Rioja  
365 categorized Rioja wines as higher in PSQ than French wines from Côtes du Rhône. In both cases,  
366 wines were PDO products. The authors attributed this effect to consumers' familiarity with wines  
367 from their own region. We found the same pattern of responses in the three countries that are familiar  
368 with the PDO system. In Finland, people from JH also identified their traditional cheese as higher in  
369 PSQ than the industrial counterpart whereas they were not able to differentiate PDO from non-PDO  
370 foreign products. However, people from foreign countries also differentiate the two cheeses in a  
371 similar way. This could be explained, to a certain extent, by the fact that Finnish cheeses were the  
372 cheese-pair with the highest number of sensory attributes significantly different between them (data  
373 not shown).

374 In the present study, we found that PSQ was related to liking to a certain extent ( $r = 0.508$ ) but the  
375 correlation is somehow weaker for domestic compared to foreign cheeses. This supports our second  
376 hypothesis. Consumers may have developed their own mental representation of a high quality product  
377 for the local PDO cheese, based on their repeated experiences with this cheese. They learn to identify  
378 quality cues that are not only based on their liking for cheeses in general. This is not completely in  
379 line with Hopfer & Heymann (2014) who found a high correlation between liking and PSQ on

380 Californian consumers for Cabernet Sauvignon wines. But, other factors such as the diversity of tested  
381 products and the product category, may impact correlation values. As the studies in this area are too  
382 scarce to be conclusive, further work is needed to better understand the relationships between PSQ  
383 and liking and its modulation by familiarity.

384 Sensory attributes driving PSQ were quite similar among consumers from different origins. Sáenz-  
385 Navajas, Ballester, Pêcher, Peyron, & Valentin (2013) also reported agreement among 56 wine  
386 consumers from La Rioja (Spain) and 52 consumers from Côtes du Rhône (France) regarding drivers  
387 of wine aroma PSQ. This could have been expected, as similar trend were observed across countries:  
388 Italian cheeses were scored high in PSQ and traditional Finnish cheese got high scores than its  
389 industrial counterpart. Thus, this result is not in contradiction with the idea that for familiar PDO  
390 products, consumers may develop a concept of “Quality” somehow diverging from their “quality”  
391 concept of cheeses in general.

392 Finally, it is necessary to indicate that more studies would be necessary to confirm the findings of the  
393 present work, especially regarding the differences in sensory quality perception between PDO and  
394 non-PDO cheeses. In fact, the unavoidable limited number of samples to include in the study forced  
395 to choose few cheeses, so the results could not be extrapolated to cheeses with or without PDO.  
396 Another limitation is that, if it had been done in other parts of Europe, the results could have been  
397 somewhat different, depending on familiarization and cultural aspects.

## 398 **5. Conclusions**

399 The results of this research suggest that PSQ depends to a certain extent on consumer origin, probably  
400 due to familiarity with local products. Only small differences in sensory drivers of PSQ have been  
401 found across consumers from different regions. However, as local cheeses were perceived as higher  
402 in PSQ than non-local cheeses, it indicated that over a general trend, familiarity modulates PSQ.

403 The correlation between PSQ and liking is significant but only moderate, suggesting that PSQ is a  
404 distinct judgment from liking that includes other dimensions. The relation between PSQ and liking is  
405 stronger for non-local cheeses than for local-cheeses, reinforcing the idea that familiarity affect PSQ.

406 **6. Acknowledgments**

407 The authors thank M<sup>a</sup> Pilar Fernandez Gil from University of the Basque Country UPV/EHU (Vitoria-  
408 Gasteiz, Spain), Anna Garavaldi and Valeria Musi from Centro Ricerche Produzioni Animali Sensory  
409 Laboratory (Reggio Emilia, Italy) for their support in consumers' sessions, Florence Bérodiér from  
410 Comité Interprofessionnel du Gruyère de Comté (Poligny Cedex, France) and Kari Finska from Valio  
411 Ltd. (Helsinki, Finland) for their support in French and Finnish cheeses supply, respectively. The  
412 authors also want to thank the consumers and the trained assessors for their participation.

413 **7. Formatting of funding sources**

414 This research did not receive any specific grant from funding agencies in the public, commercial, or  
415 not-for-profit sector.

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