

1 Consumer-led approach to adapt a food-odors emotional lexicon for the Spanish population: a
2 tool for designing the scent of food spaces.

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15 **KEYWORDS**

16 Sensory, Scents, Feelings, User-centered

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19 **ABSTRACT**

20 Aromas are powerful stimuli capable of triggering emotions. The Geneva Emotion and Odor
21 Scale (GEOS) was developed to measure the affective response to odors, and was later adapted
22 to other countries and cultures (EOSs). Also, an universal scale was proposed (UniGEOS) to be
23 used regardless of the culture, but without considering Spanish-speaking cultures. During the
24 present research, a lexicon for measuring the emotions evoked by food-related odors has been
25 developed, adapting the aforementioned scales to the Spanish population and using a
26 consumer-led approach. Using EOSs lists as starting point, the procedure was: to discard non-
27 emotional terms and translate the selected ones, to group the emotions and remove the
28 irrelevant ones for the food-odors category, and to test the lexicon. The developed lexicon
29 (SEFrOS) contained 6 categories, 25 terms. The lexicon shared some dimensions with EOSs, but
30 with specific differences, maybe related to culture or the food-linked nature of the lexicon.

31 **PRACTICAL APPLICATIONS**

32 Emotions elicited by foods have been investigated during the last years to favor proper products
33 positioning in the market. Odors have been used to modulate customer perceptions and
34 attitudes towards products and stores, because of being closely linked to these emotions'
35 elicitation. Although some lexicons have been developed to assess food-related emotions, no
36 lexicon has been developed to specifically evaluate the emotions elicited by food-odors, and to
37 study the emotions elicited by the odor of food-related spaces. This research presents the
38 development of a new lexicon for food-odors, using previously validated odor scales as starting
39 point, and adapting them to the Spanish population, well-known because of its eating-out model
40 closely related to different food spaces.

41 1. INTRODUCTION

42 The study of the emotional response elicited by food and beverages has gained relevance in the
43 last decade, being a tool with potential to decipher the drivers of consumer food choice and
44 consumption behavior (e.g.: Cardello et al., 2016; Kenney & Adhikari, 2016; King, Meiselman &
45 Carr, 2010). Some of the most well-known drivers of emotions, capable of influencing
46 consumers' behavior, are odors and aromas (Chrea et al., 2009; Ferdenzi et al., 2011). Different
47 marketing strategies have taken advantage of this relationship, eliciting specific moods in
48 consumers when exposed to some retail and/or products odorants (Rimkute, Moraes & Ferreira,
49 2016), but not much research has been conducted studying the emotions elicited by food odors,
50 important environmental scents in some sites (restaurants, food markets, coffee shops,
51 bakeries, etc.). Guéguen and Petr (2006) studied the effect of lemon and lavender odors on the
52 time and the amount of money consumers spent in a restaurant. Ouyang et al. (2018)
53 investigated the effect of three different aromas on customers' emotions, perceptions of food
54 quality, entrée selection, and the restaurant environment. These authors used candle diffusers
55 to release the aroma and asked diners to respond several questions using 7-point semantic
56 differential scales (e.g.: relaxed-neutral-stimulating). The emotions listed in the scales included
57 arousal emotions such as "relaxed/stimulated" and "calm/excited" based on the paper
58 Spangenberg et al. (2005), and pleasure emotions such as "unhappy/happy,"
59 "annoyed/pleased," "dissatisfied/satisfied," and "melancholic/contented" extracted from
60 Mattila & Wirtz (2001). Results showed that food odors elicited significant differences in
61 pleasure emotions but not in arousal emotions.

62 To expand understanding on how different aromas can elicit certain emotions, the development
63 of suitable tools to measure emotions is needed (Porcherot, 2010) and different authors have
64 developed generic or product-specific lexicons to verbally measure food-evoked emotions (e.g:
65 Bhumiratana, Adhikari & Chambers, 2014; Gunaratne et al., 2019; Hu & Lee, 2018; King &

66 Meiselman, 2010; Mora et al., 2019). Different generic lexicons have been developed for
67 evaluating everyday odors, such as the Geneva Emotion and Odor Scale (GEOS) (Chrea et al.,
68 2009), but there is a lack of methodologies to measure feelings and emotions triggered by
69 gastronomic spaces and/or experiences. One of the first emotional lexicons developed to
70 measure feelings related to aroma exposure was GEOS (Chrea et al., 2009).

71 Culture might affect use, dimension, understanding of the emotional terms, and consumers'
72 familiarity with the product. Therefore, emotional lexicons should be used by consumers
73 belonging to the culture for which the lexicon has been designed, because terms understanding
74 can influence the emotional connection that consumers have with the assessed product (van
75 Zyl, 2016; van Zyl & Meiselman, 2015). GEOS was developed for the French-speaking population
76 of Switzerland, but was then translated into other languages: English for UK (LEOS: Ferdenzi et
77 al., 2011), Singapore (SEOS: Ferdenzi et al., 2011) and USA consumers (FEOS and DEOS: Ferdenzi
78 et al., 2013); Chinese (BEOS: Ferdenzi et al., 2013); and Brazilian Portuguese (CEOS: Ferdenzi et
79 al., 2013). Besides adapting the lexicon to several cultures and languages, Ferdenzi et al. (2013)
80 proposed the UniGEOS, a universal scale to measure self-reported odor-related feelings, which
81 included the most relevant terms for the different cultures. However, neither Spanish nor
82 African related cultures were considered for the universal lexicon development (Ferdenzi et al.,
83 2013). The Spanish population is well known because of a specific "eating-out" model (Díaz-
84 Mendez & García-Espejo, 2017) a food engaged culture in which eating spaces are very relevant
85 and might elicit a variety of emotions. Therefore, having a research tool which allows
86 investigating the emotional response to different environmental aspects of these spaces (e.g.:
87 odors) can be of great utility.

88 Several methodologies can be used and have been reported to develop sensory and emotional
89 lexicons, with different approaches regarding consumers' involvement. Chaya et al. (2015) and
90 Mora et al. (2020) suggested involving consumers during the whole process: generation,

91 reduction, grouping and validation of terms. Danner et al. (2016) and Ferrarini et al. (2010)
92 included consumers in the steps related to reduction of irrelevant items and validation. Finally,
93 Gmuer et al. (2015) followed a linguistic approach in which consumers were just included during
94 the validation stage. Usually, during the generation stage, an existing set of terms is translated
95 into the targeted language, using a back-translation methodology when the lexicon is going to
96 be developed for a non-English speaking culture (e.g.: Chrea et al., 2009; Ferrariri et al., 2010;
97 Gmuer et al., 2015). For this back-translation approach, two bilingual native speakers participate
98 translating and back-translating the terms to the source and target language in a cyclic process
99 which ends when no differences are detected between the translated versions (Brislin, 1970).
100 Although back-translation is a very expanded methodology, new consumer-centered
101 alternatives have been proposed. Hu and Lee (2019) used a multiple-choice questionnaire for
102 consumers to translate the Coffee Drinking Experience lexicon (Bhumiratana, Adhikari &
103 Chambers, 2014) from English to Korean and Chinese. This methodology considered, not only
104 the language of the end-user, but also culture, reflecting consumers' perception and their use
105 of feelings (Hu & Lee, 2019).

106 Sniffing a key odorant, or volatile compound representative of a food, can evoke memories and
107 emotions associated with the food itself or pasts experiences (e.g.: a bakery, a specific
108 restaurant, etc.). This kind of emotional association could be useful for industry and HORECA
109 (HOTel REstaurant and CAtering sector) to better reach consumers and understand the feelings
110 linked to their products and/or spaces. For all these reasons, the aim of the present research
111 was to develop an emotional lexicon to measure the emotional response elicited by food odors
112 for the Spanish population, using the preexisting Emotion and Odor Scales (EOSs), and following
113 a consumer-led approach.

114 **2. MATERIAL AND METHODS**

115 Different phases were followed to develop the Spanish version for Spaniards of the EOS. The
116 protocol and procedures used in the present study were approved by the Basque Culinary
117 Center scientific committee, which stated a waiver consent. All articles from the Declaration of
118 Helsinki and the 2016/679 EU Regulation on the protection of natural persons regarding the
119 processing of personal data and on the free movement of such data were met. Participants were
120 assigned a personal code to ensure anonymity. The experimental procedure of each phase was
121 explained, and a written consent was signed by all participants before starting the study. The
122 procedure is shown in Fig. 1.

123 **2.1. Stage 1: consumer-led translation**

124 A total of 112 Spanish consumers (73% females, mean = 34, SD = 11.9) completed an online
125 survey containing a multiple-choice questionnaire to translate each English emotional term into
126 Spanish, following the methodology proposed by Hu and Lee (2019). Respondents had to choose
127 the most appropriate translation for a series of words which may describe feelings elicited by
128 food odors. Data from participants who did not meet the English level criteria (to have scored
129 over a B2 in the Cambridge English Scale or equivalent, or to have lived in an English-speaking
130 country for at least 2 years) were removed for the analysis (20 responses).

131 The questionnaire included all the items from the different EOSs developed in: Switzerland
132 (Geneva), United Kingdom (Liverpool) and the United States (Arkansas and California) (Chrea et
133 al., 2009; Ferdenzi et al., 2011; Ferdenzi et al., 2013). The list was previously checked following
134 the method proposed by van Zyl and Meiselman (2015) to remove “non-emotional terms”.
135 Emotional terms include emotions, feelings, and affective terms, and are defined as being
136 internal and being mental and primarily focused on affect (not behavior or cognition). Each term
137 was compared with the emotional lists published by Clore, Ortony, and Foss (1987) and Laros
138 and Steenkamp (2005) containing 564 and 50 emotional terms, respectively. The resultant list
139 was translated from English to Spanish, providing 3-4 options selected from the Collins English-

140 Spanish dictionary, and Espasa synonyms and antonyms dictionary (HarperCollins, 1996; Espasa
141 Libros, 2011 respectively). The options “I do not know” and “other: ...” were also included. Also,
142 respondents were asked to report any emotion or feeling that were not listed, but they
143 considered useful to measure food-evoked emotions. The final list of translated Spanish terms
144 was selected by mention frequency, as suggested by Hu and Lee (2019), choosing those terms
145 with higher frequency of mention.

146 **2.2. Stage 2: sorting task to group emotions**

147 Fifty participants (55% females, mean age 37 years old) were recruited for this step. Consumers
148 received a short explanation about the meanings of ‘emotion’ and ‘feeling’ according to
149 Porcherot et al. (2016). Then, consumers had to group the emotional terms from the translated
150 list by meaning, using their own criteria. For this purpose, consumers were instructed to evoke
151 food scents; a sentence was added at the beginning of the questionnaire to facilitate the
152 evocation task: “please, remind the scents you detect when walking in a fruit store, when
153 entering the cinema, when walking through a food market...”.

154 Consumers were free to create as many emotional terms groups as they considered relevant. A
155 fixed group labeled as ‘irrelevant’ was included in the questionnaire, in which participants could
156 include all those terms they considered not-important or not food-related. The terms included
157 in this ‘irrelevant’ group for at least 30% of consumers were removed from the lexicon (Gmuer
158 et al., 2015 and Mora et al. 2020). To minimize bias, all terms included in the sorting task were
159 presented in a randomized order for each consumer.

160 The resulting emotional groups were analyzed by Multidimensional Scaling (MDS). MDS is a
161 multivariate technique that can display the data from a similarity matrix in a map. The similarity
162 matrix was created using the frequency of each pair of words grouped together. The MDS
163 treated data from a proximity matrix between a series of N objects to the coordinates of the
164 same objects in a p-dimensional space through the use of the algorithm “Scaling by Majorizing

165 a Convex Function”, which minimizes the Normalized Stress. To determine the correct number
166 of dimensions needed to obtain a true representation of data, stress should be low, and the
167 Shepard diagram should be as linear as possible (Addinsoft, 2019). Once the configuration of the
168 dimensions was identified, HCA was performed on the coordinates of each term to group similar
169 emotions into categories. Emotions were grouped using Euclidean distance and the Ward’s
170 criterion of aggregation. All statistical analyses were done using XLSTAT (XLSTAT Version
171 2020.2.2, USA) (Addinsoft, 2019).

172 **2.3. Stage 3: test of lexicon**

173 A panel of 117 consumers (61% females, mean age of 38 years old) evaluated 10 odor samples
174 made using food grade chemicals representative from a variety of foods and locations (Merck
175 KGaA, Darmstadt, Germany) (Table 1). One ml of a 1000 mg L⁻¹ solution of each volatile
176 compound (suprathreshold concentration) was poured into 2 ml microcentrifuge tubes
177 (Eppendorf Iberica, Spain) and coded with 3-digit random numbers. Samples were presented in
178 a random order to each consumer using a Complete Balanced Block design. Participants were
179 asked to open each microcentrifuge vial 2 cm from nostrils for 30 seconds while deeply but
180 normally breathing. Before sniffing each sample, and between samples, consumers had to smell
181 cotton cloths that had been slightly moistened with distilled water and heated for 15 s in a
182 microwave before giving them to consumers. In addition, maximum of 5 participants were
183 scheduled at the same time to perform the test in the taste room. After smelling each sample,
184 consumers were asked to rate overall liking on a 9-point scale, and to rate the intensity of the
185 feelings (the lexicon with the 6 emotion categories) associated to each odorant on a linear scale,
186 anchored from ‘not at all’ to ‘very intense’. To minimize bias, the order of the 6 emotion
187 categories was randomized for each consumer. Consumers were instructed to focus on the
188 feelings associated to each specific odor sample, and not to their general mood. Data collection
189 was done using Fizz software (Biosystemes, Couternon, France).

190 One-way analysis of Variance (ANOVA) followed by a post-hoc test (Tukey HSD) was carried out
191 on liking and each emotional category. Significant differences were determined with a
192 significance level of 0.05, unless stated otherwise. Hierarchical Cluster Analysis (HCA) was
193 carried out using the average ratings of each emotional category by odor. The cluster analysis
194 was based on the Euclidean distance, and the Ward algorithm was used as the agglomerative
195 method. All statistical analyses were conducted using XLSTAT (XLSTAT Version 2020.2.2, USA)
196 (Addinsoft, 2019).

197 3. RESULTS

198 The initial list, resulting from the combination of the different EOS and after removing the
199 common terms, had 73 terms. The 73 terms were then checked with the emotional lists of Clore,
200 Ortony and Foss (1987) and Laros and Steenkamp (2005), which included affective terms,
201 emotions, and feelings, to remove the non-emotional terms and resulting in a set of 49 feelings
202 (Table 2). Less than 10% of respondents answered the final open question for reporting any
203 emotion or feeling not previously listed, but which they considered useful to measure food-
204 evoked emotions. All those terms were mainly related to sensory descriptors or contexts (e.g.:
205 'vinegary', 'sweet', 'at home') and, therefore, were not included in the final list.

206 The multiple-choice questionnaire results suggested removing 4 English terms, because
207 consumers used a single Spanish term to refer to several English words. 'Alegre' was the word
208 selected to express *jolly* and *joyful* feelings; 'tranquilo' was the term selected when *calm* and
209 *peaceful* were shown; both *disgusted* and *nauseous* were equivalent to 'asqueado' for
210 consumers; and, finally, *bliss* and *happy* were translated by 'felicidad/feliz' in Spanish. It is
211 important to note that only 18 of the 49 terms were translated with a single and common word
212 by at least 80% of participants (Table 2). The option 'I do not know' was the first one for most
213 consumers when the terms *bliss* and *drowsy* were shown, therefore the option selected for the
214 Spanish lexicon was the second in frequency.

215 Then, during the sorting task, the Spanish terms were grouped, and the 20 terms included in the
216 'irrelevant' group by at least 30% of the consumers were removed. The remaining terms were
217 inputted into a similarity matrix and the MDS showed different dimensional representation
218 spaces. A final number of 16 dimensions was chosen because the stress value of the 16
219 dimensions was the weakest (0.009) and the Shepard diagram was the most linear one (Fig. 2).
220 Projection of emotions on the 16-dimension configuration was input in HCA resulting in 6
221 clusters of emotions (Table 3). Cluster 1 was characterized mainly by positive emotions such as
222 *happy* or *joyful*, Cluster 2 comprised emotions as *passionate* or *attracted*, Cluster 3 included
223 unpleasant feelings such as *disgusted* or *sad*, Cluster 4 was defined by the feelings *hungry* and
224 *thirsty*, Cluster 5 was represented by *melancholy*-like feelings, and Cluster 6 was associated with
225 *relaxed* and *calm*.

226 Once the lexicon was defined, its ability for food-related odor assessment was studied, using the
227 aforementioned set of 10 samples (Table 1). The ANOVA results showed that the 6 identified
228 categories were significantly different among samples, which also received significantly different
229 liking scores. Post-hoc analyses identified different odor groups for each emotional category
230 (Table 4). The dendrogram (Fig. 4) was helpful for the interpretation of the grouping of odors by
231 HCA. Vanilla, cinnamon, and bitter almond odors were grouped together and elicited higher
232 ratings on positive emotions. Odor samples described with anise, roasted nut, and banana
233 descriptors (Table 1) also elicited positive emotions, but post-hoc analysis revealed that these
234 molecules were less relaxing than the previous group. Also, the roasted nut-like odor elicited
235 higher ratings of the *hungry* and *thirsty* category than the other samples. The odors that evoked
236 higher scores on negative emotions were the cheese, vegetable, mushroom, and green-like
237 scents. Cheese was the odor with the highest score in Cluster 3, which included negative
238 emotions such as *disgusted*. The aforementioned odor group, which included vegetable,
239 mushroom, and green-like odors, elicited lower scores in cluster 3 (*disgusted*), and lower
240 activation scores (cluster 6 – *relaxed/calms*) than the cheese-like odor. Although grouping of

241 odors were obtained by HCA, which is a projective technique, results of the Tukey test supported
242 these findings (Table 4).

243 Post-hoc results from the ANOVA test allowed identifying the significant differences among
244 samples for both liking, and the emotions categories. Liking was similarly rated for some of the
245 samples and the emotion profile was pretty similar for those samples, but provided additional
246 information to better understand liking differences. An example can be seen when comparing
247 for example vanilla and banana scents: liking was significantly different, but some of the main
248 emotional categories liked similarly (e.g.: joyful). Both scents could be considered positive from
249 a consumer perspective, but vanilla elicited significantly higher scores on some of the emotional
250 categories: passionate, hungry and relaxed.

251 **4. DISCUSSION**

252 The main objective of the present study was to develop a validated questionnaire for measuring
253 emotions elicited by food odors for the Spanish population. The resulting Spanish lexicon has
254 some similarities with the preexisting lexicons, but some differences were observed. Because
255 this is the first emotional lexicon focusing just on food-related odors, it is impossible to
256 determine if the differences with other lexicons were due to the food-related character of
257 SEFrOS, or because of cultural differences. This Spanish lexicon (SEFrOS) included 25 terms,
258 similarly to the universal lexicon UniGEOS, which had been developed to include relevant
259 feelings for different cultures. The different EOSs, which were developed before UniGEOS, were
260 longer and included 33 to 37 terms: CEOS was composed by 33 terms, GEOS and SEOS contained
261 36 terms, and finally, LEOS, BEOS, FEOS and DEOS with 37 items (Chrea et al., 2009; Ferdenzi et
262 al., 2011; Ferdenzi et al., 2013). Because of being wider, to provide more options to consumers,
263 these lexicons were chosen as the starting point for the present development but removing the
264 non-emotional terms as recommended by van Zyl and Meiselman (2015). For example,

265 Spirituality, which is present in UniGEOS was not considered an emotional category, and has
266 been mainly associated to Asian cultures.

267 The great reduction of terms during the sorting task stage, could be due to 1) cultural differences,
268 or 2) to the specific nature of the lexicon, developed to be used only for food-related odors.
269 Some of the terms included in all EOSs, such as *romantic* or *refreshed*, were considered
270 'irrelevant' for Spanish consumers when asked to group emotions related to food-odors.

271 In the same manner than other cultural linked-EOSs, SEFrOS had singular emotional categories.
272 Cluster 1 of the SEFrOS, which included positive emotions such as *amusement* or *fantastic*, also
273 included the feeling *energetic*. In other EOSs, Energy is a category itself, which includes the term
274 *energetic* together with other feelings such as *revitalized* or *stimulated*. These feelings were not
275 selected by the Spanish consumers as relevant, maybe because of some cultural-linked reason,
276 or maybe because of not considering those emotions linked to food odors. Although many terms
277 related to Sensuality/desire are present in the EOSs and UniGEOS, most of them were discarded
278 by Spanish consumers (e.g.: *romantic*, *sentimental*, etc.); a Desire category (Cluster 2) was
279 included in the SEFrOS, grouping the terms *passionate*, *attracted*, *desire* and *pleasure*. The
280 Hunger-thirsty category (Cluster 4) that was not present in the lexicons developed by Chrea et
281 al. (2009) and Ferdenzi et al. (2011, 2013) was included in the SEFrOS, maybe because these
282 feelings were directly prompted by food odors.

283 Consumer-centered lexicon development methodologies have gained relevance in the scientific
284 literature, recently, Hu and Lee (2019) proposed using consumers to translate the terms of a
285 preexisting lexicon to their own mother language, which could include a more realistic image
286 about the expression of emotions within the studied culture. In Spain, English is taught as the
287 first foreign language since the age of 6 years old, and average students have a B2 Cambridge
288 English Scale level or equivalent by the end of high school. Therefore, involving consumers in
289 the translation task can provide information on how consumers understand the English word

290 and how they explain the idea in their own mother language (Hu & Lee, 2019). If a representative
291 sample of consumers from a given culture selects the meaning of an emotional term, the
292 translation should be more representative than the one obtained from a traditional back-
293 translation approach. Prescott (2017) defined granularity as “the degree of fine distinction that
294 individuals make in referring to similar emotional states”. The lexicon developed during the
295 present study pretended including the cultural biases related to the granularity concept, and
296 therefore a consumer-led translation process was chosen. Different Spanish-speaking cultures
297 could show significant differences in understanding and expressing the emotional terms, and
298 also to link them to food odors (van Zyl and Meiselman, 2015, 2016); therefore, further studies
299 should be developed to explore the utility of this lexicon in other Spanish-speaking cultures.

300 A consumer-centered approach was also used during the grouping terms phase. During this
301 stage, sorting was chosen to ease the task of reducing the terms list, and to remove the
302 irrelevant feelings. Mora et al. (2020) reported that using this methodology could be useful for
303 reducing steps if compared with a traditional lexicon development method. Also, during the
304 present lexicon development, an additional step was reduced by including a mandatory
305 ‘irrelevant’ group during the sorting task.

306 Scores for the emotional categories of the SEFrOS in the different odor samples were related to
307 the liking scores, explaining the emotions that drove liking of the studied food scents. Previous
308 studies have shown that the measurement of emotions can provide information beyond liking,
309 being liking correlated with emotion ratings of positive valence (e.g.: pleased, satisfied) (e.g.:
310 Cardello et al., 2012). On the contrary, other research has reported that emotions and liking
311 ratings do not always agree (King et al., 2010, Porcherot al., 2010). Responses for the odor
312 samples assessed in the present study showed that liking was related to most positive emotions’
313 clusters. Results revealed some potential reasons for these liking scores; for example, vanilla
314 and banana received significantly different scores for liking, and the emotional categories

315 passionate-attracted-desire-pleasure (cluster 2), hungry-thirsty (cluster 4), and relaxed-calm
316 (cluster 6), vanilla odor received higher scores than banana odor. These results were in
317 concordance with the circumplex model of emotions (Larsen & Diener, 1992; Russel, 1980;
318 Watson & Tellegen, 1985): the valence axis, associated with pleasure-displeasure emotions, was
319 aligned with liking, and the arousal axis, related to activation-deactivation emotions, provided
320 information about the samples in relation to the calm/relax feelings that odors elicited. Further
321 studies are needed to test SEFrOS with a wider odors' set, researching the discrimination
322 capability of the lexicon in different contexts, and the impact of the consumption context on the
323 emotions elicited by the different food scents.

324 **5. CONCLUSIONS**

325 An emotional lexicon for food-related odors has been developed for the Spanish population,
326 starting from EOSs and using a consumer-centered approach for the translation, grouping of the
327 terms, and lexicon testing stages. The consumer-centered approach resulted in a fast and
328 reliable method for developing the lexicon; also, using consumers for the translation stage was
329 useful to include a realistic standpoint to express the emotions in their mother language. The
330 resulted 25-terms lexicon with 6 groups of feelings was useful to study the emotions elicited by
331 10 different food odors in Spaniards, providing data on why some of the odors were more liked
332 than others. Further research should address the potential adaptation of SEFrOS to other
333 Spanish-speaking countries. Also, due to the importance of the eating-out model of the Spanish
334 culture, having a tool such as SEFrOS is useful to study consumer emotions related to
335 experiences in different HORECA settings with a characteristic odor, or defining which food-
336 related scents should be appropriate for different HORECA settings.

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8. TABLES

Table 1. List of volatile compounds used for testing the lexicon

Sample	Compound	Descriptor*	Threshold** ($\mu\text{g L}^{-1}$)	Example of locations
1	Dimethyl sulfide	Vegetable, sulfurous, cabbage, organic, wet earth	0.16 - 12	Restaurant, canteen
2	Anethol	Anise, spicy, sweet	50	Bakery, patisserie, cafeteria
3	Vanillin	Vanilla, caramel, chocolate, sweet	20 - 200	Bakery, patisserie, cafeteria
4	Cinnamaldehyde	Cinnamon, clove, spicy	50 - 750	Bakery, patisserie, cafeteria
5	Benzaldehyde	Bitter almond, cherry, sweet, burnt sugar, malt, roasted pepper	350 - 3500	Bakery, patisserie, cafeteria, fruit stand, candy store
6	Isovaleric acid	Cheese, pungent, animal	170 - 700	Restaurant, cheese stand, farmers market
7	2-Acetylpyridine	Roasted nut, popcorn, oily	19	Cinema, restaurant, snack bar
8	1-Octen-3-ol	Mushroom, cucumber, earthy, fat, floral, cheesy, creamy, herbaceous, vegetable	1	Restaurant, fruit stand, picnic area, farmers market
9	Isoamyl acetate	Banana, pear, apple, glue	2	Fruit stand, candy store, bakery, patisserie
10	2-Methoxy-3-(1-methylpropyl) pyrazine	Green, vegetable, pepper	0.002 - 0.016	Fruit stand, restaurant, picnic area, farmers market

*(Kim et al., 2019; SAFC, 2011)

** Leffingwell and Cantrell (2004)

Table 2. Spanish translation of the EOSs lexicons

English	Spanish	English	Spanish	English	Spanish
<i>Admiration</i>	Admiración (85.9%)	<i>Good</i>	Bien (90.2%)	<i>Pleasure</i>	Placer (72.8%)
<i>Affectionate</i>	Afectuoso (47.8%)	<i>Happy</i>	Feliz (81.5%)	<i>Refreshed</i>	Renovado (75%)
<i>Amusement</i>	Diversión (46.7%)	<i>Hungry</i>	Hambriento (100%)	<i>Relaxed</i>	Relajado (79.3%)
<i>Angry</i>	Enfadado (81.5%)	<i>In love</i>	Enamorado (89.1%)	<i>Romantic</i>	Romántico (90.2%)
<i>Ashamed</i>	Avergonzado (76.1%)	<i>Interesting</i>	Interesado (64.1%)	<i>Sad</i>	Triste (94.6%)
<i>Attracted</i>	Atraído (53.3%)	<i>Intimate</i>	Íntimo (71.7%)	<i>Satisfaction</i>	Satisfacción (81.5%)
<i>Bliss*</i>	Felicidad (25%)	<i>Irritated</i>	Irritado (56.5%)	<i>Sensual</i>	Sensual (95.7%)
<i>Calm</i>	Tranquilo (73.9%)	<i>Jolly</i>	Alegre (53.3%)	<i>Sentimental</i>	Sentimental (69.6%)
<i>Comfortable</i>	Cómodo (89.1%)	<i>Joyful</i>	Alegre (53.3%)	<i>Serene</i>	Sereno (66.3%)
<i>Delighted</i>	Encantado (67.4%)	<i>Lustful</i>	Lujurioso (47.8%)	<i>Soothed</i>	Aliviado (45.7%)
<i>Desire</i>	Deseo (90.2%)	<i>Melancholy</i>	Melancólico (73.9%)	<i>Thirsty</i>	Sediento (88%)
<i>Disgusted</i>	Asqueado (55.4%)	<i>Nauseous</i>	Asqueado (41.3%)	<i>Sexy</i>	Sexy (87%)
<i>Dissatisfaction</i>	Descontento (57.6%)	<i>Nostalgic</i>	Nostálgico (75%)	<i>Uncomfortable</i>	Incómodo (95.7%)
<i>Drowsy*</i>	Somnoliento (30.4%)	<i>Overwhelmed</i>	Abrumado (65.2%)	<i>Unpleasant</i>	Desagradable (83.7%)
<i>Energetic</i>	Enérgico (89.1%)	<i>Passionate</i>	Apasionado (89.1%)	<i>Unpleasantly surprised</i>	Desagradablemente sorprendido (62%)
<i>Enthusiastic</i>	Entusiasta (52.5%)	<i>Peaceful</i>	Tranquilo (38%)		
<i>Fantastic</i>	Fantástico (66.3%)	<i>Pleasantly surprised</i>	Gratamente sorprendido (84.8%)		

Spanish terms in bold are translations chosen by more than 80% of the respondents. Terms with * are those whose first chosen option was "Do not know"

Table 3. Cluster analysis of the 25 terms of the lexicon (original Spanish terms signaled in italic font)

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
Alegre <i>(Joyful)</i>	Apasionado <i>(Passionate)</i>	Asqueado <i>(Disgusted)</i>	Hambriento <i>(Hungry)</i>	Melancólico <i>(Melancholy)</i>	Relajado <i>(Relaxed)</i>
Bien <i>(Good)</i>	Atraído <i>(Attracted)</i>	Desagradable <i>(Unpleasant)</i>	Sediento <i>(Thirsty)</i>	Nostálgico <i>(Nostalgic)</i>	Tranquilo <i>(Calm)</i>
Diversión <i>(Amusement)</i>	Deseo <i>(Desire)</i>	Desagradablemente sorprendido <i>(Unpleasantly surprised)</i>		Sentimental <i>(Sentimental)</i>	
Encantado <i>(Delighted)</i>	Placer <i>(Pleasure)</i>	Descontento <i>(Dissatisfaction)</i>			
Enérgico <i>(Energetic)</i>		Triste <i>(Sad)</i>			
Fantástico <i>(Fantastic)</i>					
Feliz <i>(Happy)</i>					
Gratamente sorprendido <i>(Pleasantly surprised)</i>					
Satisfacción <i>(Satisfaction)</i>					

Table 4. Results of the differences in the emotional categories and liking among odor samples (1-10)

Categories	p-value	Dimethyl sulfide (DMS)	Anethol	Vanillin	Cinnamaldehyde	Benzaldehyde	Isovaleric acid	2-Acetylpyridine	1-Octen-3-ol	Isoamyl acetate	2-methoxy-3-(1-methylpropyl) pyrazine
		Vegetable	Anise	Vanilla	Cinnamon	Bitter almond	Cheese	Roasted nut	Mushroom	Banana	Green
<i>Liking</i>	<0.0001	3.9 e	6.0c	7.4 a	6.9 ab	6.8 ab	2.4 f	5.9 c	4.9 d	6.4 bc	3.7 e
Cluster 1 Joyful-Good-Amusement-Delighted-Energetic-Fantastic-Happy-Pleasantly surprised-Satisfaction	<0.0001	2.7 de	4.2 bc	5.7 a	5.7 a	5.8 a	1.9 e	4.5 b	3.4 cd	5.1 ab	2.6 de
Cluster 2 Passionate-Attracted-Desire-Pleasure	<0.0001	2.3 ef	3.8 cd	5.6 a	5.3 ab	5.4 ab	1.8 f	3.8 cd	3.1 de	4.6 bc	2.3 ef
Cluster 3 Disgusted-Unpleasant-Unpleasantly surprised-Dissatisfaction-Sad	<0.0001	5.0 b	2.5 e	2.3 e	2.3 e	2.3 e	6.2 a	3.1 de	3.6 cd	2.6 e	4.4 bc
Cluster 4 Hungry-Thirsty	<0.0001	2.9 de	3.2 bcd	4.2 ab	3.9 abc	4.0 abc	2.1 e	4.5 a	3.1 cde	3.1 cd	2.1 e
Cluster 5 Melancholy-Nostalgic-Sentimental	<0.0001	2.4 de	3.9 bc	4.8 ab	4.8 ab	4.9 a	2.0 e	3.9 bc	3.3 cd	4.3 abc	2.7 de
Cluster 6 Relaxed-Calm	<0.0001	2.7 de	4.2 bc	5.4 a	5.4 a	4.7 ab	1.9 e	3.4 cd	3.6 cd	4.3 bc	3.0 d

Different letters within the same row indicate different post-hoc groupings by Tukey's HSD ($p \leq 0.05$)

9. FIGURE CAPTIONS

Fig 1. Flow chart of the lexicon development.

Fig. 2. Shepard diagram resulting from the MDS analysis of the semantic lexicon.

Fig. 3. Dendrogram with the clusters of emotions in the resulting 6 categories.

Fig. 4. Dendrogram with the clusterization of odors into 4 groups.