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

Elena Romeo-Arroyo[a,b], María Mora[a,b,*], Laura Vázquez-Araújo[a,b]

[a] Basque Culinary Center, Faculty of Gastronomy Sciences, Mondragon Unibertsitatea, Donostia-San Sebastián

[b] BCCInnovation, Technology Center in Gastronomy, Basque Culinary Center, Donostia-San Sebastián

Running title: Spanish emotional food-related odor scale

(*) Corresponding author. Email: mmora@bculinary.com

KEYWORDS

Sensory, Scents, Feelings, User-centered

ABSTRACT

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

PRACTICAL APPLICATIONS

Emotions elicited by foods have been investigated during the last years to favor proper products positioning in the market. Odors have been used to modulate customer perceptions and attitudes towards products and stores, because of being closely linked to these emotions' induction. Although some lexicons have been developed to assess food-related emotions, no lexicon has been developed to specifically evaluate the emotions elicited by food-odors, and which can also be used to study the emotions elicited by the odor of food-related spaces. This research presents the development of this lexicon, using previously validated odor scales as starting point, and adapting them to the Spanish population, well-known because of being a culture closely related to food spaces (eating-out model).

1. INTRODUCTION

The study of the emotional response elicited by food and beverages has gained relevance in the last decade, being a tool with potential to decipher the drivers of consumer food choice and consumption behavior (e.g.: Cardello et al., 2016; Kenney & Adhikari, 2016; King, Meiselman & Carr, 2010). Some of the most well-known drivers of emotions, capable of influencing consumers' behavior, are odors and aromas (Chrea et al., 2009; Ferdenzi et al., 2011). Different marketing strategies have taken advantage of this relationship, eliciting specific moods in consumers when exposed to some retail and/or products odorants (Rimkute, Moraes & Ferreira, 2016), but not much research has been conducted studying the emotions elicited by food odors understood as environmental scents. Guéguen & Petr (2006) studied the effect of lemon and lavender odors on the length of time and the amount of money spent in a restaurant by consumers. Also, Ouyang et al. (2018) showed that food aromas influenced some emotions such as pleasure and customers' impressions of the food quality in a restaurant environment, but emotions were measured using a list of terms chosen by authors without considering a specific lexicon.

To expand understanding on how different aromas can elicit certain emotions, the development of suitable tools to measure emotions is needed (Porcherot, 2010) and different authors have developed generic or product-specific lexicons to verbally measure food-evoked emotions (e.g: King & Meiselman, 2010; Bhumiratana, Adhikari & Chambers, 2014; Gunaratne et al., 2019; Hu & Lee, 2018; Mora et al., 2019). Different generic lexicons have been developed for evaluating everyday odors, such as the Geneva Emotion and Odor Scale (GEOS) (Chrea et al., 2009), but there is a lack of methodologies to measure feelings and emotions triggered by spaces and gastronomic experiences. One of the first emotional lexicons developed to measure feelings related to aroma exposure was GEOS (Chrea et al., 2009). Culture might affect use, dimension, meaning of the emotional terms, and consumers' familiarity with the product. Emotional

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

Several methodologies can be used and have been reported to develop sensory and emotional lexicons, with different level of consumers involvement. Chaya et al. (2015) and Mora et al. (2020) suggested involving consumers during the whole process: generation, reduction, grouping and validation of terms. Danner et al. (2016) and Ferrarini et al. (2010) included consumers in the steps related to reduction of irrelevant items and validation. And finally, Gmuer et al. (2015) followed a linguistic approach in which consumers were just included during the validation stage. Generally, during the generation stage, an existing set of terms is used to be translated into the targeted language, using a back-translation methodology. During this back-translation approach, two bilingual native speakers participate translating and back-translating the terms to the source and target language in a cyclic process which ends when no differences are detected between the translated versions (Brislin, 1970). Although back-

translation is a very expanded methodology, new consumer-centered alternatives have been proposed. Hu and Lee (2019) used a multiple-choice questionnaire for consumers to translate the Coffee Drinking Experience lexicon (Bhumiratana, Adhikari & Chambers, 2014) from English to Korean and Chinese. This methodology considered, not only the language of the end-user, but also culture, reflecting consumers' perception and their use of feelings (Hu & Lee, 2019).

Sniffing a key odorant, or volatile compound representative of a food, can evoke memories and emotions associated with the food itself or pasts experiences (e.g.: a bakery, a specific restaurant, etc.) and this kind of emotional association could be useful for industry and HORECA (HOtel REstaurant and CAtering sector) to better reach consumers and understand the feelings linked to their products and spaces. For all these reasons, the aim of the present research was to develop an emotional lexicon to measure the emotional response elicited by food odors for the Spanish population, using the preexisting Emotion and Odor Scales (EOSs), and following a consumer-led approach. The developed scale can be used to determine the emotions elicited by foods as well as dinning or gastronomic spaces.

2. MATERIAL AND METHODS

Different stages were conducted to develop the Spanish version for Spaniards of the EOS. The protocol and procedures used in this study were approved by the Basque Culinary Center scientific committee, which stated a waiver consent. All articles from the Declaration of Helsinki and the 2016/679 EU Regulation on the protection of natural persons regarding the processing of personal data and on the free movement of such data were met. Participants were assigned a unique code to ensure anonymity. The experimental procedure of each phase was explained, and a written consent form indicating voluntary participation was signed by all participants prior to beginning the study. The procedure is described in Fig. 1.

2.1. Stage 1: consumer-led translation

A total of 112 Spanish consumers (73% females, mean age 34 years old) completed an online survey containing a multiple-choice questionnaire to translate each English emotional term into Spanish, following the methodology proposed by Hu and Lee (2019). They were asked to choose the most appropriate translation for each word to describe feelings elicited by food odors. Data from participants who did not meet the English level criteria (at least a B2 in the Cambridge English Scale or equivalent) were removed from the analysis (20 responses).

The questionnaire included all the items present in the EOSs developed in Switzerland (Geneva), United Kingdom (Liverpool) and the United States (Arkansas and California) (Chrea et al., 2009; Ferdenzi et al., 2011; Ferdenzi et al., 2013). The list was previously checked following the method proposed by van Zyl & Meiselman (2015) to remove non-emotional terms. Each term was compared with the emotional lists published by Clore, Ortony, and Foss (1987) and Laros and Steenkamp (2005) containing 564 and 50 terms, respectively. The resultant list was translated from English to Spanish, providing 3-4 options selected from Collins English-Spanish dictionary and Espasa synonyms and antonyms dictionary (HarperCollins, 1996; Espasa Libros, 2011 respectively). The options "I do not know" and "other: ……." were also included. The final Spanish term was selected because of the frequency analysis of the responses using Microsoft Office Excel 2016.

2.2. Stage 2: sorting task to group emotions

Fifty participants (55% females, mean age 37 years old) were recruited for this step. Consumers received a short explanation about the meanings of 'emotion' and 'feeling' and were then asked to group the feelings from the translated consumer-led list. Food scents had to be evoked while grouping the terms they considered associated. Consumers were free to create as many groups as they considered relevant. A group labeled as 'irrelevant' was mandatory, in which participants could include all the emotional terms they considered not-important or not food-related. The

terms included in this 'irrelevant' group for at least 30% of consumers were removed from the lexicon. To minimize bias, all emotions were presented in a randomized order for each consumer.

The resulting emotional groups were analyzed by Multidimensional Scaling (MDS). MDS is a multivariate technique that can display the data from a similarity matrix in a map. The similarity matrix was created using the frequency of each pair of words grouped together. The MDS treated data from a proximity matrix between a series of N objects to the coordinates of the same objects in a p-dimensional space through the use of the algorithm "Scaling by Majorizing a Convex Function", which minimizes the Normalized Stress. To determine the correct number of dimensions needed to obtain a true representation of data, stress should be low, and the Shepard diagram should be as linear as possible (Addinsoft, 2019). Once the dimensions' configuration was determined, HCA was performed on the projection of terms to group similar emotions into categories. Emotions were grouped using Euclidean distance and the Ward's criterion of aggregation. All statistical analyses were done using XLSTAT (XLSTAT Version 2020.2.2, USA) (Addinsoft, 2019).

2.3. Stage 3: test of lexicon

A panel of 117 consumers (61% females, mean age of 38 years old) evaluated 10 odor samples made using food grade chemicals representative from a variety of foods and locations (Merck KGaA, Darmstadt, Germany) (Table 1). One ml of a 1000 mg L^{-1} solution of each volatile compound was poured into microcentrifuge tubes and coded with 3-digit random numbers. Samples were presented in random order to each consumer using a Complete Balanced Block design. After smelling each sample, consumers were asked to rate overall liking on a 9-point scale and then to rate the intensity of the evoked feelings associated to each odorant on a linear scale, anchored from 'not at all' to 'very intense'. To minimize bias, the order of the 6 emotion categories identified during the previous stage was randomized for each consumer. Consumers

were instructed to focus on the feelings associated to each specific odor sample, and not to their general mood. Data collection was done using Fizz software (Biosystemes, Couternon, France).

One-way analysis of Variance (ANOVA) followed by a post-hoc test (Tukey HSD) was carried out on liking and each emotional category. Significant differences were determined with a significance level of 0.05, unless stated otherwise. Principal Component Analysis (PCA) was performed on the average ratings of each emotional category to explore the relationships between emotional categories and odors. Liking was used as a supplementary (non-active) variable in the analysis. Hierarchical Cluster Analysis (HCA) was carried out using the averages of each emotional category per odor. The cluster analysis was based on the Euclidean distance, and the Ward algorithm was used as the agglomerative method. All statistical analyses were conducted using XLSTAT (XLSTAT Version 2020.2.2, USA) (Addinsoft, 2019).

3. RESULTS

The initial list, resulting from the combination of the different EOS and after removing the common terms, consisted of a list of 73 terms. The 73 terms were then checked with the emotional lists of Clore, Ortony and Foss (1987) and Laros and Steenkamp (2005) to remove the non-emotional terms, resulting in a set of 49 feelings (Table 2).

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

consumers when the terms *bliss* and *drowsy* were shown, therefore the option selected for the Spanish lexicon for those words was the second in frequency.

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

Once the lexicon was defined, its ability for food-related odor discrimination was assessed, using the aforementioned set of 10 samples. The ANOVA results showed that the 6 identified categories were significantly different among samples, which received significantly different liking scores. Post-hoc analyses identified different odor groups for each emotional category (Table 4). A Principal Component Analysis (PCA) was conducted to project the relationship among odors and emotions. The first 2 Principal Components (PC) of the PCA explained 97.35% of the data variance (Fig. 4.a). PC1 was positively correlated with Cluster 1 (which grouped pleasant emotions, 0.993), Cluster 2 (linked to *desire,* 0.986), Cluster 4 (*hungry-thirsty*, 0.856), Cluster 5 (nostalgia, 0.994), and Cluster 6 (*relaxed-calm,* 0.960), and liking (supplementary variable). However, Cluster 3 (-0.956), including negative emotions, was negatively correlated with PC1. Although, PC1 explained most of the data variance (91.84%), PC2 contributed

212 importantly to the emotional disposition of samples. This component was positively correlated
213 with Cluster 4 (0.514).

214 The observations plot (Fig. 4.b.) was helpful for the interpretation of the grouping of odors by
215 HCA. Vanilla, cinnamon, and bitter almond odors were grouped together and positively related
216 to the PC1, and therefore, elicited higher ratings on positive emotions. Odor samples described
217 with anise, roasted nut, and banana descriptors (Kim et al., 2019; SAFC, 2011) also elicited
218 positive emotions, but post-hoc analysis revealed that these molecules were less relaxing than
219 the previous group. Also, the roasted nut-like odor was positively related to PC2, eliciting higher
220 ratings of the *hungry* and *thirsty* category than the other samples. Because PC2 represented only
221 5.50% of the total variance, the role of Cluster 4 (*hungry and thirsty*) seemed to be less relevant
222 for the general grouping of food odors. The odors related to negative emotions were the cheese,
223 vegetable, mushroom, and green-like scents. Cheese was positively related to Cluster 3, which
224 included negative emotions such as *disgusted*, being the odor with the highest score in the
225 negative emotions category. The aforementioned odor group, which included vegetable,
226 mushroom, and green-like odors, elicited lower scores in cluster 3 (*disgusted*), and lower
227 activation scores (cluster 6 – *relaxed/calm*) than the cheese-like odor. Although grouping of
228 odors were obtained by HCA, which is a projective technique, results of the Tukey test supported
229 these findings (Table 4).

230 **4. DISCUSSION**

231 The main objective of the present study was to develop a validated questionnaire for measuring
232 emotions elicited by food odors for the Spanish population. The resulting Spanish lexicon
233 presented some similarities with the preexisting lexicons, but some differences were observed.
234 This Spanish lexicon (SEFrOS) comprised 25 terms, similarly to the universal lexicon UniGEOS,
235 developed to include relevant feelings for different cultures, but without the contribution of
236 Spanish-speaking or African cultures (Ferdenzi et al., 2013). The different EOSs, which were

developed before UniGEOS, were longer and included 33 to 37 terms: CEOS was composed by 33 terms, GEOS and SEOS contained 36 terms, and finally, LEOS, BEOS, FEOS and DEOS with 37 items (Chrea et al., 2009; Ferdenzi et al., 2011; Ferdenzi et al., 2013). Because of being wider and providing more options to consumers, these lexicons were chosen as the starting point for the present development, but removing those non-emotional terms as recommended by van Zyl & Meiselman (2015). Among the terms removed because of not being considered emotional terms was the whole Spirituality category, present in the UniGEOS and mainly associated to Asian cultures.

A total of 49 terms were presented to consumers in the online survey. During the translation stage, some feelings were removed by consumers because the English terms shared a translation/meaning for the Spanish consumers. The reduced lexicon due to translation consisted of 45 terms.

The further reduction of terms, during the sorting task stage, could be due to two reasons: cultural differences, or the specific use of the lexicon to food-related odors. Some of the terms included in EOSs, such as *romantic* or *refreshed,* which were present in all the EOS lists, were considered 'irrelevant' for Spanish consumers when asked about food-odors evoked emotions.

Similarly to other cultural linked EOSs, SEFrOS had singular emotional categories. Cluster 1 of SEFrOS, composed by positive emotions such as *amusement* or *fantastic*, also included the feeling *energetic*. In the other EOSs, Energy is a category itself, which included the term *energetic,* but also other feelings such as *revitalized* or *stimulated*, not selected by Spanish consumers as relevant. Spaniards discarded those terms, maybe because of not being relevant for their culture, or maybe because of not considering those emotions linked to food odors. Although many terms related to Sensuality/desire are present in EOSs and UniGEOS, most of them were discarded by Spanish consumers (e.g.: *romantic*, *sentimental*, etc.), but a Desire category (Cluster 2) was included in the SEFrOS which grouped the terms *passionate, attracted*,

desire and *pleasure*. The Hunger-thirsty category (Cluster 4), that was not present in the lexicons developed by Chrea et al. (2009) and Ferdenzi et al. (2011, 2013), was included in SEFrOS, maybe because these feelings were directly prompted by food odors.

Consumer-centered lexicon development methodologies have gained relevance in the scientific literature during the last years (Chaya et al., 2015; Mora et al., 2020; van Zyl & Meiselman, 2015). Recently, Hu and Lee (2019) proposed using consumers to translate the terms of a preexisting lexicon to their own mother language, which could include a more realistic image about the expression of emotions within the studied culture. English is usually taught as the first foreign language since school stage, hence involving consumers in translating the emotional terms provides information on how consumers understand the English word and how they explain the idea in their own mother language (Hu & Lee, 2019). Therefore, if a representative sample of consumers from a given culture choose a common meaning for an emotional term, the translation should be more representative than the one obtained from a traditional back-translation approach. Prescott (2017) defined granularity as "the degree of fine distinction that individuals make in referring to similar emotional states". Using consumers to translate the different feelings implied indirectly considering some cultural biases related to this granularity concept. Different Spanish-speaking cultures could show significant differences in understanding and expressing the emotional terms, and also to link them to food odors, such as van Zyl and Meiselman (2015, 2016) demonstrated in their study related to beverages.

In addition to the translation stage, the same consumer-centered approach was used during the grouping terms phase. During this stage, sorting was chosen to ease the task of reducing the terms list and to remove the irrelevant feelings. As reported by Mora et al. (2020), using this methodology could be useful for reducing steps and developing an emotional lexicon with a less time-consuming approach. During the present lexicon development, an additional step was reduced by including a mandatory 'irrelevant' group during the sorting task. SEFrOS, which

resulted useful to group the emotions related to food scents, was successfully developed using a consumer-centered methodology which can also be implemented in an online and home-use-test format, easing consumers participation.

5. CONCLUSIONS

An emotional lexicon for food-related odors has been developed for the Spanish population, starting from EOSs and using a consumer-centered approach for translation and grouping of the terms and testing the lexicon. A 25-terms lexicon with 6 groups of feelings proved to be useful to assess a set of food odors and study the different emotions that these elicited in Spaniards. The consumer-centered approach resulted in a fast and reliable method for developing an emotional lexicon; also, including consumers in the translation stage was useful to include a realistic standpoint related to the expression of the emotions in their mother language. Further research should address the potential adaptation of SEFrOS to other Spanish-speaking countries. Also, due to the importance of gastronomy and the eating-out model of the Spanish culture, having a tool such as SEFrOS is useful to study consumer emotions related to experiences in different HORECA settings with a characteristic odor, or defining which food-related scents should be appropriate for different HORECA settings.

6. ACKNOWLEDGEMENTS

This study was supported by Diputación Foral de Gipuzkoa through the program Gastronomía 4.0 (grant number: 2019-GAST-24). The authors want to acknowledge all the participants of the consumer studies for their helpful collaboration.

7. REFERENCES

Addinsoft. (2019). XLSTAT statistical and data analysis solution. Long Island,NY, USA. Retrieved from https://www.xlstat.com.

Bhumiratana, N., Adhikari, K., & Chambers IV, E. (2014). The development of an emotion lexicon for the coffee drinking experience. *Food Research International, 61*, 83–92. https://doi.org/10.1016/j.foodres.2014.03.008.

Brislin, Richard W. (1970), Back Translation for Cross-Cultural Research, *Journal of Cross-Cultural Psychology*, *1* (3), 185–216. https://doi.org/10.1177/135910457000100301.

Cardello, A. V., Pineau, B., Paisley, A. G., Roigard, C. M., Chheang, S. L., Guo, L. F., Hedderley, D., & Jaeger, S. R. (2016). Cognitive and emotional differentiators for beer: An exploratory study focusing on "uniqueness". *Food Quality and Preference, 54*, 23–38. https://doi.org/10.1016/j.foodqual.2016.07.001.

Chaya, C., Eaton, C., Hewson, L., Vázquez, R. F., Fernández-Ruiz, V., Smart, K. A., & Hort, J. (2015). Developing a reduced consumer-led lexicon to measure emotional response to beer. *Food Quality and Preference, 45*, 100–112. https://doi.org/10.1016/j.foodqual.2015.06.003.

Chrea, C., Grandjean, D., Delplanque, S., Cayeux, I., Le Calvé, B., Aymard, L., Velazco, M. I., Sander, D., & Scherer, K. R. (2009). Mapping the semantic space for the subjective experience of emotional responses to odors. *Chemical Senses*, *34*(1), 49–62. https://doi.org/10.1093/chemse/bjn052.

Clore, G. L., Ortony, A., & Foss, M. A. (1987). The psychological foundations of the affective lexicon. *Journal of Personality and Social Psychology*, *53*(4), 751–766. https://doi.org/10.1037/0022-3514.53.4.751.

Danner, L., Ristic, R., Johnson, T. E., Meiselman, H. L., Hoek, A. C., Jeffery, D. W., & Bastian, S. E.

(2016). Context and wine quality effects on consumers' mood, emotions, liking and willingness to pay for Australian Shiraz wines. *Food Research International, 89*, 254–265. https://doi.org/10.1016/j.foodres.2016.08.006.

Díaz-Méndez, C., & García-Espejo, I. (2017). Eating out in Spain: Motivations, sociability and consumer contexts. *Appetite, 119*, 14-22. https://doi: 10.1016/j.appet.2017.03.047

Espasa Libros, S. L. U. (2011). *Diccionario de sinónimos y antónimos* (6a ed.). Madrid: Espasa Libros, S. L. U.

Ferdenzi, C., Delplanque, S., Barbosa, P., Court, K., Guinard, J. X., Guo, T., Roberts, S.C., Schiemer, A., Porcherot, C., Cayeux, I., Sander, D., & Grandjean, D. (2013). Affective semantic space of scents. Towards a universal scale to measure self-reported odor-related feelings. *Food Quality and Preference*, 30(2), 128–138. https://doi.org/10.1016/j.foodqual.2013.04.010.

Ferdenzi, C., Schirmer, A., Roberts, S. C., Delplanque, S., Porcherot, C., Cayeux, I., Velazco, M. I., Sander, D., Scherer, K.R., & Grandjean, D. (2011). Affective dimensions of odor perception: A comparison between Swiss, British, and Singaporean populations. *Emotion*, *11*(5), 1168–1181. https://doi.org/10.1037/a0022853.

Ferrarini, R., Carbognin, C., Casarotti, E. M., Nicolis, E., Nencini, A., & Meneghini, A. M. (2010). The emotional response to wine consumption. *Food Quality and Preference, 21*(7), 720–725. https://doi.org/10.1016/j.foodqual.2010.06.004.

Gmuer, A., Nuessli Guth, J., Runte, M., & Siegrist, M. (2015). From emotion to language: Application of a systematic, linguistic-based approach to design a food-associated emotion lexicon. *Food Quality and Preference*, *40*, 77–86. https://doi.org/10.1016/j.foodqual.2014.09.001.

Guéguen, N., & Petr, C. (2006). Odors and consumer behavior in a restaurant. *International*

353 *Journal of Hospitality Management*, *25*(2), 335–339.
354 https://doi.org/10.1016/j.ijhm.2005.04.007.

355 Gunaratne, T. M., Gonzalez Viejo, C., Fuentes, S., Torrico, D. D., Gunaratne, N. M., Ashman, H.,
356 & Dunshea, F. R. (2019). Development of emotion lexicons to describe chocolate using the
357 Check-All-That-Apply (CATA) methodology across Asian and Western groups. *Food*
358 *Research International*, *115*, 526–534. https://doi.org/10.1016/j.foodres.2018.10.001.

359 HarperCollins Publishers. (1996). *Collins Pocket Plus English-Spanish dictionary.* Madrid: Grijalbo
360 Mondadori.

361 Hu, X., & Lee, J. (2019). Emotions elicited while drinking coffee: A cross-cultural comparison
362 between Korean and Chinese consumers. *Food Quality and Preference, 76*, 160–168.
363 https://doi.org/10.1016/j.foodqual.2018.08.020.

364 Kenney, E., & Adhikari, K. (2016). Recent developments in identifying and quantifying emotions
365 during food consumption. *Journal of the Science of Food and Agriculture*, *96*(11), 3627–
366 3630. https://doi.org/10.1002/jsfa.7717.

367 Kim, S., Chen, J., Cheng, T., Gindulyte, A., He, J., He, S., Li, Q., Shoemaker, B. A., Thiessen, P. A.,
368 Yu, B., Zaslavsky, L., Zhang, J., & Bolton, E. E. (2019). PubChem 2019 update: improved
369 access to chemical data. Nucleic Acids Research, 47(D1), D1102–D1109.
370 https://doi.org/10.1093/nar/gky1033.

371 King, S. C., & Meiselman, H. L. (2010). Development of a method to measure consumer emotions
372 associated with foods. *Food Quality and Preference, 21*(2), 168–177.
373 https://doi.org/10.1016/j.foodqual.2009.02.005.

374 Laros, F. J. M., & Steenkamp, J.-B. E. M. (2005). Emotions in consumer behavior: a hierarchical
375 approach. *Journal of Business Research*, *58*(10), 1437–1445.

https://doi.org/10.1016/j.jbusres.2003.09.013.

Mora, M., Giussani, B., Pagliarini, E., & Chaya, C. (2019). Improvement of an emotional lexicon for the evaluation of beers. *Food Quality and Preference, 71,* 158-162. https://doi.org/10.1016/j.foodqual.2018.06.007.

Mora, M., de Matos, A. D., Fernández-Ruiz, V., Briz, T., & Chaya, C. (2020). Comparison of methods to develop an emotional lexicon of wine: Conventional vs rapid-method approach. *Food Quality and Preference, 83*, 103920. https://doi.org/10.1016/j.foodqual.2020.103920.

Ouyang, Y., Behnke, C., Almanza, B., & Ghiselli, R. (2018). The influence of food aromas on restaurant consumer emotions, perceptions, and purchases. *Journal of Hospitality Marketing & Management*, *27*(4), 405–423. https://doi.org/10.1080/19368623.2017.1374225.

Prescott, J. (2017). Some considerations in the measurement of emotions in sensory and consumer research. *Food Quality and Preference, 62*, 360–368. https://doi.org/10.1016/j.foodqual.2017.04.005.

Rimkute, J., Moraes, C., & Ferreira, C. (2016). The effects of scent on consumer behaviour. *International Journal of Consumer Studies, 40,* 24–34. https://doi: 10.1111/ijcs.12206.

SAFC, 2011. Flavor and Fragrances Catalog. European edition. SAFC Specialties, Madrid.

van Zyl, H. (2016). 19 – Emotion in Beverages. In H. L. Meiselman (Ed.), *Emotion Measurement* (pp. 473–499). Woodhead Publishing. https://doi.org/10.1016/B978-8-08-100508-8.00019-9.

van Zyl, H., & Meiselman, H. L. (2015). The roles of culture and language in designing emotion lists: Comparing the same language in different English and Spanish speaking

countries. *Food Quality and Preference, 41,* 201–213. https://doi.org/10.1016/j.foodqual.2014.12.003.

van Zyl, H., & Meiselman, H. L. (2016). An update on the roles of culture and language in designing emotion lists: English, Spanish and Portuguese. *Food Quality and Preference*, *51*, 72–76. https://doi.org/10.1016/j.foodqual.2016.02.019.

8. TABLES

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

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

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

Table 2. Spanish translation of the EOSs lexicons

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

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

Categories		p-value	1	2	3	4	5	6	7	8	9	10
Liking		<0,0001	3,878 e	5,989 c	7,386 a	6,923 ab	6,846 ab	2,372 f	5,901 c	4,890 d	6,392 bc	3,707 e
Cluster 1	Joyful-Good-Amusement-Delighted-Energetic-Fantastic-Happy-Pleasantly surprised-Satisfaction	<0,0001	2,646 de	4,198 bc	5,731 a	5,650 a	5,783 a	1,931 e	4,463 b	3,395 cd	5,111 ab	2,547 de
Cluster 2	Passionate-Attracted-Desire-Pleasure	<0,0001	2,306 ef	3,782 cd	5,620 a	5,278 ab	5,421 ab	1,765 f	3,751 cd	3,061 de	4,608 bc	2,306 ef
Cluster 3	Disgusted-Unpleasant-Unpleasantly surprised-Dissatisfaction-Sad	<0,0001	4,999 b	2,447 e	2,265 e	2,328 e	2,314 e	6,153 a	3,110 de	3,581 cd	2,550 e	4,400 bc
Cluster 4	Hungry-Thirsty	<0,0001	2,910 de	3,188 bcd	4,159 ab	3,915 abc	4,001 abc	2,130 e	4,449 a	3,075 cde	3,125 cd	2,105 e
Cluster 5	Melancholy-Nostalgic-Sentimental	<0,0001	2,382 de	3,845 bc	4,788 ab	4,752 ab	4,940 a	2,018 e	3,886 bc	3,300 cd	4,287 abc	2,704 de
Cluster 6	Relaxed-Calm	<0,0001	2,683 de	4,150 bc	5,415 a	5,424 a	4,669 ab	1,880 e	3,424 cd	3,598 cd	4,343 bc	2,958 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. First factorial plot of the PCA based on the emotional response to odor samples. (a) Correlation plot of emotions (b) Projection of samples. Groupings are based on clustering results of the same data set.