Determination of the characteristic sensory profiles of Aloreña table-olive

By H. Galán-Soldevilla, P. Ruiz Pérez-Cacho and J.A. Hernández Campuzano

1. INTRODUCTION

Aloreña table-olives are seasoned cracked olives of the Aloreña variety that conserve their stone intact and are attached to the stalk. Their external color is usually green, greenish-yellow or light brown, depending on their degree of fermentation. They have a crunchy texture and a bitter taste, making them especially distinctive from the seasoned olives prepared from other varieties. They are characterized by the presence of a low level of oleuropein (the bitter component of the olive) that does not need any treatment with sodium hydroxide to sweeten it, and by the typical local products contained in the seasoning like fennel, thyme, garlic and peppers (Arroyo-López et al., 2008a). There are three different processing styles of Aloreña table-olives: fresh green olives, traditional olives and cured olives (BOJA nº 215, 2009/11/04). Aloreña olives are unique to and typical of the Guadalhorce region (Málaga, Spain). This area includes a total of 19 municipalities spread between the Sierra de las Nieves and the Guadalhorce Valley. This valley, surrounded by a group of mountains in the north and slightly influenced by the sea, has unique climatic characteristics which have promoted this variety’s quality.

Although sensory characteristics are determinant in defining a foodstuff, sensory studies concerning table olives are scant (Kanavouras et al., 2005; Panagou et al., 2006; Gonzalez et al., 2007; Marsilio et al., 2008; Aponte et al., 2010; Lanza et al., 2010; Valencic et al., 2010). The use of these sensory profiles may contribute to the identity of Aloreña olives by means of a sensory quality certification (Scintu del Caro et al., 2010).

The first step involved in generating a sensory profile is to develop a wide number of relevant descriptive terms. Once the initial list of vocabulary has been generated, the selection of the main descriptors must be performed. Multivariate techniques have been used for selecting the relevant descriptive terms that can differentiate among products. In a following step, a definition of each descriptor will be given and a suitable reference product will also be assigned to each of these descriptors. Once the panel has assimilated
2. MATERIAL AND METHODS

2.1. Samples

2.1.1. Table-olives used in the generation and selection of the sensory attributes

Aloreña table-olives (fresh green, traditional and cured olives) were provided by local producers during the 2006/2007 growing season. A series of samples of Aloreña olives that display the most important specific characteristics were tasted in order to obtain the characteristic sensory profiles.

The olive samples were taken directly from commercial containers and placed in normalized tasting glasses (IOOC 1987) each with a minimum of 5 olives covered in brine from which the seasonings were previously removed. The glasses were covered with watch glasses and kept closed for at least 1 hour at room temperature before tasting. Mineral water was used for mouth rinsing between each sample.

2.1.2. Table-olives used in the sensory profile

For the sensory profile, 15 different Aloreña extra or first grade table-olives (IOOC 2004) from the 2009/10 growing season of the three processing styles were analyzed: 7 fresh green olives, 4 traditional olives and 4 cured olives.

2.2. Sensory characterization

2.2.1. Generation and selection of the sensory attributes

The procedure followed to obtain the vocabulary is based on ISO standards (ISO 1994; ISO 2003). Nine sessions of 1 to 2 hours each were conducted in order to develop the sensory profile: 5 preliminary ones were held to establish the test conditions and to generate and define the vocabulary and 4 sessions for the selection of the lexicon. Four to five samples, labeled with 3-digit random numbers were served, one-at-a-time, over a session. Samples were randomly allotted to sessions.

The sensory terms were generated individually by the assessors in the tasting booths using the “unguided free selection” technique (Guerrero 1999; Pérez-Cacho et al., 2005) and the sensory attributes were selected in accordance with ISO (1994).

The data were analyzed using Statistica 8.0 (StatSoft Inc., Tulsa, OK USA). Principal Component Analysis (PCA) was used to reduce the number of attributes and the sensory profile sheet for the sensory analysis of table-olives was made. Finally, the Kruskall-Wallis test was carried out to examine the discriminatory ability of each descriptor selected.

2.2.2. Sensory profile

The sensory profiles of the three processing styles were assessed in 15 samples using the sensory profile sheet developed by the trained panel in the previous step. Three sessions of 1 hour (4-5 samples/session) were conducted to complete the analysis. Sample preparation, serving and tasting procedures were also established (Galán-Soldevilla and Ruiz Pérez-Cacho 2010). The appearance attributes were assessed by the whole panel on the complete sample before carrying out the tasting. Next, in each sample, first the odor was evaluated, then the flavor (aromas, basic tastes, and trigeminal sensations) and, finally, the texture attributes. The evaluation of the odor was made by direct aspiration of the air over the tasting glass in 2 phases: first with the glass kept still to detect any possible defects, and then after shaking it gently to determine the different odor attributes.

Data analysis was carried out with the Statistical Analysis System 9.2 (SAS Institute Inc., Cary, NC, USA) and an SPSS 17.4 mixed of Nested Design ANOVA and Factorial ANOVA (Xijk = Processing style + Sample (processing style) + Assessor + (Assessor x Processing style) were used to evaluate the sensory profile data. Duncan’s post hoc test was applied to detect significant differences among the samples. A canonical analysis was used to group similar samples within each processing style in order to define the sensory profile of Aloreña olives.

2.2.3. Assessors

Nine (3 male, 6 female) highly trained panelists from the Sensory Laboratory at Córdoba University, (Spain), aged 27 to 55, participated in this study. The Assessors were selected and trained following international standards (ISO 1985; ISO 1993; ISO 2003; ISO 2008). The selection of assessors was based on detection, recognition and discrimination tests and on the ability of candidates to memorize and communicate sensory impressions (Pérez-Cacho et al., 2005). These panelists had completed 300 h of basic training in all aspects of sensory analysis and had prior experience in the quantitative descriptive analysis of different products (Galán-Soldevilla et al., 2005; Pérez-Cacho et al., 2005;
Pérez-Cacho et al., 2008). In addition, the panel had undergone 15 hours of specific training in table-olives.

2.2.4. Sensory laboratory

Testing was carried out in the sensory laboratory located at the University of Córdoba (Córdoba, Spain), equipped with a round table for training sessions and individual booths, in accordance with the international standards (ISO 2007).

3. RESULTS AND DISCUSSION

3.1. Generation and selection of sensory attributes

The sensory terms were generated individually by the assessors in the tasting booths using the “unguided free selection” technique (Damasio and Costell, 1991; Guerrero, 1996; Montouto-Graña et al., 2002; Pérez-Cacho et al., 2005). Next, the panel leader held a discussion to come to an agreement on the descriptors and a consensus lexicon was developed. The initial working list (Table 1) included 59 terms: 3 for appearance, 24 for odor, 27 for flavor and 5 for texture attributes.

In the following panel sessions (round-table method), the initial working list was reduced in accordance with international standards (ISO 1994). Firstly, the appearance attributes were excluded from the analysis because they would be qualitatively assessed by the whole panel on the complete sample before carrying out the tasting. Next, the 19 negative odor/aroma attributes were omitted from the initial list because they did not describe the product. In addition, some odor/aroma descriptors were grouped in a single term: ripe fruit and green fruit as fruit and spices/herbs and fresh.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Preliminary descriptors developed in the lexicon generation for Aloreña table olives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Odor</td>
</tr>
<tr>
<td>Hue</td>
<td>Positive attributes</td>
</tr>
<tr>
<td>Luminance</td>
<td>Green fruit</td>
</tr>
<tr>
<td>Uniformity of color</td>
<td>Ripen fruit</td>
</tr>
<tr>
<td>Spices/herbs</td>
<td>Fresh vegetable</td>
</tr>
<tr>
<td>Fresh vegetable</td>
<td>Green pepper</td>
</tr>
<tr>
<td>Green pepper</td>
<td>Red pepper</td>
</tr>
<tr>
<td>Red pepper</td>
<td>Garlic</td>
</tr>
<tr>
<td>Garlic</td>
<td>Fennel</td>
</tr>
<tr>
<td>Fennel</td>
<td>Thyme</td>
</tr>
<tr>
<td>Thyme</td>
<td>Wood</td>
</tr>
<tr>
<td>Lactic</td>
<td>Olive oil</td>
</tr>
<tr>
<td>Hay</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td></td>
</tr>
<tr>
<td>Olive oil</td>
<td></td>
</tr>
<tr>
<td>Negative attributes</td>
<td>Negative attributes</td>
</tr>
<tr>
<td>Musty/humid</td>
<td>Musty/humid</td>
</tr>
<tr>
<td>Winery/vinegary</td>
<td>Winery/vinegary</td>
</tr>
<tr>
<td>Apechin/vegetable water</td>
<td>Apechin/vegetable water</td>
</tr>
<tr>
<td>Fermentation</td>
<td>Fermentation</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Rancid</td>
</tr>
<tr>
<td>Rancid</td>
<td>Rancid butter</td>
</tr>
<tr>
<td>Rancid butter</td>
<td>Soap</td>
</tr>
<tr>
<td>Soap</td>
<td>Lupin</td>
</tr>
<tr>
<td>Lupin</td>
<td>Burnt tire</td>
</tr>
<tr>
<td>Burnt tire</td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Sensory attributes and references developed for Aloreña table-olives

<table>
<thead>
<tr>
<th>Sensory attribute</th>
<th>Definition</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruity odor/aroma</td>
<td>Odor/aroma characteristic of fresh olives, either ripe or unripe.</td>
<td>Extra virgin olive oil from Aloreña variety</td>
</tr>
<tr>
<td>Green odor</td>
<td>Odor/aroma characteristic of newly cut grass</td>
<td>1 drop of cis-3-hexen-1-ol in 50 ml of water or newly cut grass</td>
</tr>
<tr>
<td>Seasoning odor/aroma</td>
<td>Odor/aroma characteristic of spices and herbs added to the Aloreña</td>
<td>Mixture of spices used in seasoning of Aloreña olives</td>
</tr>
<tr>
<td>Green pepper odor/aroma</td>
<td>Odor/aroma characteristic of fresh green pepper</td>
<td>Fresh green pepper</td>
</tr>
<tr>
<td>Red pepper odor/aroma</td>
<td>Odor/aroma characteristic fresh red pepper</td>
<td>Fresh red pepper</td>
</tr>
<tr>
<td>Garlic odor/aroma</td>
<td>Odor/aroma characteristic of fresh garlic</td>
<td>Fresh garlic</td>
</tr>
<tr>
<td>Fennel odor/aroma</td>
<td>Odor/aroma characteristic of fresh fennel</td>
<td>Fresh fennel</td>
</tr>
<tr>
<td>Thyme odor/aroma</td>
<td>Odor/aroma characteristic of fresh thyme</td>
<td>Fresh thyme</td>
</tr>
<tr>
<td>Wood odor/aroma</td>
<td>Odor/aroma characteristic of wood</td>
<td>Wood shaving in 60 ml flask</td>
</tr>
<tr>
<td>Hay odor</td>
<td>Odor of dried grass</td>
<td>Dried grass wrapped in aluminum paper</td>
</tr>
<tr>
<td>Lactic odor</td>
<td>Odor characteristic of lactic acid</td>
<td>Yoghurt</td>
</tr>
<tr>
<td>Olive oil odor/aroma</td>
<td>Aroma characteristic of fresh oil from olive perceived through the back of the nose.</td>
<td>Extra virgin olive oil from Aloreña variety</td>
</tr>
<tr>
<td>Salty</td>
<td>Basic taste produced by aqueous solutions like sodium chloride</td>
<td>2 g of salt is dissolved in 1 liter of water. 30 ml of dissolution in 50 ml plastic cup</td>
</tr>
<tr>
<td>Bitter</td>
<td>Basic taste produced by diluted aqueous solutions of caffeine</td>
<td>0.3 g of caffeine is dissolved in 1 liter of water. 30 ml of dissolution in 50 ml plastic cup</td>
</tr>
<tr>
<td>Acid</td>
<td>Basic taste produced by aqueous solutions of substances like citric acid.</td>
<td>0.3 g of citric acid is dissolved in 1 liter of water. 30 ml of dissolution in 50 ml plastic cup</td>
</tr>
<tr>
<td>Astringent</td>
<td>Complex sensation accompanied by shrinking of the skin of mucosa surface in the mouth, produced by substances such as kaki tannins</td>
<td>A piece of kaki</td>
</tr>
<tr>
<td>Pungent</td>
<td>Causing a sharp sensation of the nasal mucosa membranes</td>
<td>Vinegar of wine</td>
</tr>
<tr>
<td>Piquant</td>
<td>Causing a sharp sensation of the buccal mucosa membranes</td>
<td>Virgin oil from the Picual olive variety</td>
</tr>
<tr>
<td>Fresh</td>
<td>Sensation of reduced temperature experienced as a result of exposure to certain substances such as menthol or anise.</td>
<td>Sensation perceived during mastication of fennel (leaves).</td>
</tr>
<tr>
<td>Firmness</td>
<td>Mechanical property of texture related to the strength required to attain a certain penetration of the olive.</td>
<td>Gordal olive with stone</td>
</tr>
<tr>
<td>Crunchy</td>
<td>Mechanical property of texture related to the cohesion and strength necessary to break an olive with the teeth.</td>
<td>Gordal olive with stone</td>
</tr>
<tr>
<td>Fibrous</td>
<td>Geometrical property of texture related to the perception of strands oriented in the same direction</td>
<td>A portion of celery</td>
</tr>
<tr>
<td>Floating stone</td>
<td>Aloreña variety conserves its stone intact and is attached to the stalk.</td>
<td>Aloreña olive-table</td>
</tr>
<tr>
<td>Separation of peel during mastication</td>
<td>Texture attribute that evaluates the separation of the olive peel during mastication</td>
<td>Aloreña olive-table</td>
</tr>
</tbody>
</table>
vegetable as seasoning, resulting in 33 attributes. The sensory attributes, definitions and references are shown in Table 2. Generally, the descriptors resulting from the preliminary generation are numerous and many of them are later discarded on the basis of being vague, redundant, quantitative, synonyms, antonyms or non-discriminating terms (Stone and Sidell, 1993; ISO, 1994; Barcenas et al., 1999; Drake et al., 2001; Galán-Soldevilla et al., 2005; Pérez-Cacho et al., 2005; Retiveau et al., 2005; Riu-Amatell et al., 2008; Talavera-Bianchi and Chambers, 2008; Drake et al., 2010).

According to ISO (1994), to reduce the number of attributes and determine the most significant among them, each term was evaluated using a scale ranging from one (very slight perception) to five (very intense), and zero (0) equivalent to an absence of perception for the attribute considered (ISO 1994). Next, the tasting list was made up and 14 descriptors were rejected before the PCA analysis: 3 had the same intensity in all the samples (fibrous, floating stone and separation of peel during mastication), 7 had low number of mentions (olive oil odor, red pepper odor/aroma, fennel odor/aroma and thyme odor/aroma) and 4 were grouped (garlic odor/aroma and green pepper odor/aroma) within the “seasoning” term. It is worth mentioning that the seasoning odor and aroma are strongly influenced by the garlic or by green pepper odor and aroma. Also, it should be noted that four additional terms, although previously found to be representative of the samples, were finally not perceived in any of them and they were eliminated from the list: hay odor, wood aroma, piquant and fresh (Byrne et al., 2001; Drake et al., 2001; Pérez-Cacho et al., 2005).

PCA was then employed as a final step for selecting the attributes that best characterized the samples (ISO 1994). The resulting 15 descriptors (5 odor attributes: fruit, green, seasoning, wood and lactic; 3 aroma attributes: fruit, olive oil and seasoning; 3 basic tastes: salty, acid and bitter; 2 trigeminal attributes: astringent and pungent and 2 texture attributes: firmness and crunchy) were subjected to a PCA on the correlation matrix. A two-factor model that explains 57.7% of total variance was selected based on eigenvalue values and on the contribution of descriptors to the relevant axes. This percentage of variance explained is rather low but it allows us to select the main attributes characterizing the table olives. Other authors have found a similar percentage of variance values with sensory data (Lee et al., 2001; Riu-Aumatell et al., 2008).

Figure 1 represents the plot of the attributes on the plane defined by the first two components. The first dimension selects the main sensory attributes that define the Aloreña table-olive (fruit odor and

![Figure 1: PCA loadings plot of the 15 terms selected by the sensory panel on the first two factors (PC1 vs. PC2).]
DETERMINATION OF THE CHARACTERISTIC SENSORY PROFILES OF ALOREÑA TABLE-OLIVE

extra virgin olive oils, there are very few related to table olives (Kanavouras et al., 2005; Panagou et al., 2006; Gonzalez et al., 2007; Marsilio et al., 2008; Aponte et al., 2010; Lanza et al., 2010; Valencic et al., 2010). What is more, those works only give information on the appearance (color), texture (firmness) and basic tastes (salty, acid and bitter) and not on the odor/aroma attribute characterizing them. However, the International Olive Council has recently published a method for the sensory assessment of table-olives in order to classify them into commercial categories (IOOC, 2008). This document proposes some odor defects that agree with our sensory findings (abnormal fermentation, musty, rancid or winey-vinegary) but not positive odor and aroma attributes.

3.2. Sensory profile

The results of the ANOVA carried out on the samples are reported in Table 4. Green odor, lactic odor and acid taste are not included in this analysis because the green odor attribute is only evaluated for the green olives and the other 2 attributes for the cured ones. The effect of the factor processing style was significant only for three descriptors: fruit odor, bitter taste and firmness (p < 0.05) whereas the effect of the samples nested in each processing style was significant for all the attributes (p < 0.001). There was no significant differences among the assessors except for overall odor intensity and seasoning aroma (p < 0.05). For the (assessors x processing style) interaction effect, representing the panel’s performance, 4 attributes out of 10 were
samples were grouped into three batches: sample 12; samples 13 and 14; and sample 15.

Finally, the panel evaluations of the appearance of the olive samples showed that the fresh green ones had a light green coloring, the traditional ones a straw yellow one and the cured ones were brown.

Therefore, green olives were characterized by their green color, odor and aroma of green, fruit and seasoning, their bitter taste and firm and crunchy texture. The main differences observed between the four different sensory profiles were due to the intensity values of fruit and seasoning significantly different: odor intensity, seasoning odor, aroma intensity and seasoning aroma. It is worth mentioning that the odor and aroma intensities are strongly influenced by the seasoning odor and aroma. The main sensory differences among the three processing styles were due to a loss in the green odor/aroma notes in traditional and cured olives and the development of lactic odor and an acid taste in the cured olives. In addition, the data showed a decrease in the intensity values of fruit odor and aroma, bitter taste and firmness from the green to the cured olives. These results could be related to the manufacturing process: olives are kept in brine until their delivery when they are seasoned, developing a lactic fermentation over a more or less variable period of time (a minimum of 3 days at a refrigeration temperature for green olives, a minimum of 20 days at room temperature for traditional ones and a minimum of 90 days for cured ones). ANOVA analysis also indicated that there were differences between samples for all the attributes within each processing style and it was due to the way that they were prepared as well.

Duncan’s post hoc test was applied to detect significant differences among the samples (Tables 5, 6 and 7) and the data showed that all samples were different within each processing style. Next, a canonical analysis was used to group similar samples within each processing style in order to define their sensory profiles (Figure 3-5). For green olive samples, the first two functions (79.7% of total variability) joined samples in four different groups: samples 1, 4 and 5; sample 2; sample 3; and samples 6 and 7. For traditional olive samples, all the samples were independent groups (83.6% of total variability) and for the cured one (96.6% of total variability), samples were grouped into three batches: sample 12; samples 13 and 14; and sample 15.

Table 3

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit_o</td>
<td>-0.746647</td>
<td>-0.457762</td>
</tr>
<tr>
<td>Green_o</td>
<td>-0.864435</td>
<td>-0.015482</td>
</tr>
<tr>
<td>Seasoning_o</td>
<td>-0.645813</td>
<td>-0.052511</td>
</tr>
<tr>
<td>wood_o</td>
<td>0.465849</td>
<td>-0.453082</td>
</tr>
<tr>
<td>Lactic_o</td>
<td>0.337687</td>
<td>0.890799</td>
</tr>
<tr>
<td>Hardness</td>
<td>-0.725660</td>
<td>0.396970</td>
</tr>
<tr>
<td>Crunchy</td>
<td>-0.797972</td>
<td>0.284669</td>
</tr>
<tr>
<td>Bitter</td>
<td>-0.757340</td>
<td>-0.122927</td>
</tr>
<tr>
<td>Salty</td>
<td>-0.076766</td>
<td>-0.479144</td>
</tr>
<tr>
<td>Acid</td>
<td>0.339569</td>
<td>0.891561</td>
</tr>
<tr>
<td>Fruit_a</td>
<td>-0.870473</td>
<td>-0.158639</td>
</tr>
<tr>
<td>Olive oil_a</td>
<td>0.246646</td>
<td>-0.493226</td>
</tr>
<tr>
<td>Seasoning_a</td>
<td>-0.545734</td>
<td>0.173156</td>
</tr>
<tr>
<td>Astringent</td>
<td>-0.636097</td>
<td>0.379105</td>
</tr>
<tr>
<td>Pungent</td>
<td>-0.524271</td>
<td>0.146915</td>
</tr>
</tbody>
</table>

Table 4

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Factor</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity_o</td>
<td>Style</td>
<td>2.31</td>
<td>0.1421</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>103.34</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>3.12</td>
<td>0.0141</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>2.70</td>
<td>0.0084</td>
<td></td>
</tr>
<tr>
<td>Fruit_o</td>
<td>Style</td>
<td>7.68</td>
<td>0.0071</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>113.40</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>1.12</td>
<td>0.3607</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>1.76</td>
<td>0.0885</td>
<td></td>
</tr>
<tr>
<td>Seasoning_o</td>
<td>Style</td>
<td>3.14</td>
<td>0.0801</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>70.75</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>1.06</td>
<td>0.3925</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>3.81</td>
<td>0.0005</td>
<td></td>
</tr>
<tr>
<td>Intensity_a</td>
<td>Style</td>
<td>0.79</td>
<td>0.4765</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>86.38</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>1.65</td>
<td>0.1617</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>2.29</td>
<td>0.0235</td>
<td></td>
</tr>
<tr>
<td>Fruit_a</td>
<td>Style</td>
<td>0.51</td>
<td>0.6144</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>115.90</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>0.32</td>
<td>0.9000</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>0.35</td>
<td>0.9622</td>
<td></td>
</tr>
<tr>
<td>Seasoning_a</td>
<td>Style</td>
<td>0.46</td>
<td>0.6426</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>135.65</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>2.52</td>
<td>0.0392</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>2.87</td>
<td>0.0054</td>
<td></td>
</tr>
<tr>
<td>Bitter</td>
<td>Style</td>
<td>36.14</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>50.26</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>1.25</td>
<td>0.2099</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>1.57</td>
<td>0.1113</td>
<td></td>
</tr>
<tr>
<td>Piquant</td>
<td>Style</td>
<td>3.04</td>
<td>0.0854</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>84.07</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>0.26</td>
<td>0.9332</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>0.70</td>
<td>0.7230</td>
<td></td>
</tr>
<tr>
<td>Crunchy</td>
<td>Style</td>
<td>1.39</td>
<td>0.2863</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>22.14</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>0.64</td>
<td>0.6671</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>1.73</td>
<td>0.0953</td>
<td></td>
</tr>
<tr>
<td>Firmness</td>
<td>Style</td>
<td>4.77</td>
<td>0.0299</td>
</tr>
<tr>
<td>Sample (style)</td>
<td>25.50</td>
<td>0.0001</td>
<td></td>
</tr>
<tr>
<td>Assessor</td>
<td>1.33</td>
<td>0.2641</td>
<td></td>
</tr>
<tr>
<td>Style x Assessor</td>
<td>1.62</td>
<td>0.1217</td>
<td></td>
</tr>
</tbody>
</table>
### Table 5

Green olive mean sensory scores and corresponding Duncan’s significant difference at \( p \leq 0.05 \)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
<th>Sample 6</th>
<th>Sample 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor intensity</td>
<td>6.4a</td>
<td>7.1b</td>
<td>7.1b</td>
<td>6.5c</td>
<td>6.4a</td>
<td>6.3a</td>
<td>6.2a</td>
</tr>
<tr>
<td>Fruit odor</td>
<td>6.1a</td>
<td>7.2b</td>
<td>3.8c</td>
<td>6.9d</td>
<td>4.8e</td>
<td>6.4af</td>
<td>6.4f</td>
</tr>
<tr>
<td>Green odor</td>
<td>1.8a</td>
<td>2.7b</td>
<td>1.7a</td>
<td>2.0ac</td>
<td>2.1c</td>
<td>2.0ac</td>
<td>2.7b</td>
</tr>
<tr>
<td>Seasoning odor</td>
<td>6.5a</td>
<td>7.3b</td>
<td>7.2b</td>
<td>6.3ac</td>
<td>6.5a</td>
<td>6.4a</td>
<td>6.1c</td>
</tr>
<tr>
<td>Aroma intensity</td>
<td>5.3a</td>
<td>6.7b</td>
<td>6.9b</td>
<td>5.2ac</td>
<td>4.9c</td>
<td>6.2d</td>
<td>5.8e</td>
</tr>
<tr>
<td>Fruit aroma</td>
<td>3.5a</td>
<td>5.7b</td>
<td>2.7c</td>
<td>2.9d</td>
<td>3.7e</td>
<td>6.2f</td>
<td>5.3g</td>
</tr>
<tr>
<td>Seasoning aroma</td>
<td>5.6a</td>
<td>6.7b</td>
<td>6.7b</td>
<td>5.1c</td>
<td>5.3c</td>
<td>3.7d</td>
<td>4.5e</td>
</tr>
<tr>
<td>Bitter</td>
<td>6.2a</td>
<td>7.2b</td>
<td>7.3b</td>
<td>6.2a</td>
<td>5.4c</td>
<td>6.9d</td>
<td>6.4a</td>
</tr>
<tr>
<td>Piquant</td>
<td>4.0a</td>
<td>6.4b</td>
<td>3.8ad</td>
<td>1.8c</td>
<td>3.0d</td>
<td>3.0d</td>
<td>3.4d</td>
</tr>
<tr>
<td>Crunchy</td>
<td>7.0a</td>
<td>6.3bd</td>
<td>7.4a</td>
<td>6.0b</td>
<td>6.8ad</td>
<td>7.0ad</td>
<td>5.1c</td>
</tr>
<tr>
<td>Firmness</td>
<td>5.2a</td>
<td>6.2b</td>
<td>5.8b</td>
<td>4.7cd</td>
<td>5.1ad</td>
<td>5.8b</td>
<td>4.5c</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different with \( p \leq 0.5 \).

### Table 6

Traditional olive mean sensory scores and corresponding Duncan’s significant difference at \( p \leq 0.05 \)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sample 8</th>
<th>Sample 9</th>
<th>Sample 10</th>
<th>Sample 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor intensity</td>
<td>4.7a</td>
<td>6.7b</td>
<td>5.4c</td>
<td>5.0a</td>
</tr>
<tr>
<td>Fruit odor</td>
<td>3.7a</td>
<td>4.9b</td>
<td>3.7a</td>
<td>3.2c</td>
</tr>
<tr>
<td>Seasoning odor</td>
<td>4.9a</td>
<td>6.2b</td>
<td>5.1a</td>
<td>5.3a</td>
</tr>
<tr>
<td>Aroma intensity</td>
<td>5.3a</td>
<td>6.5b</td>
<td>5.4a</td>
<td>3.6c</td>
</tr>
<tr>
<td>Fruit aroma</td>
<td>3.3ad</td>
<td>3.4a</td>
<td>5.4b</td>
<td>2.9cd</td>
</tr>
<tr>
<td>Seasoning aroma</td>
<td>5.4a</td>
<td>6.9b</td>
<td>3.1c</td>
<td>3.3c</td>
</tr>
<tr>
<td>Bitter</td>
<td>4.5a</td>
<td>6.8b</td>
<td>3.7c</td>
<td>5.2d</td>
</tr>
<tr>
<td>Piquant</td>
<td>7.5a</td>
<td>4.6b</td>
<td>2.1c</td>
<td>5.3d</td>
</tr>
<tr>
<td>Crunchy</td>
<td>6.6a</td>
<td>6.6a</td>
<td>7.0a</td>
<td>5.6b</td>
</tr>
<tr>
<td>Firmness</td>
<td>3.9a</td>
<td>4.9b</td>
<td>4.2a</td>
<td>4.1a</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different with \( p \leq 0.5 \).

### Table 7

Cured olive mean sensory scores and corresponding Duncan’s significant difference at \( p \leq 0.05 \)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Sample 12</th>
<th>Sample 13</th>
<th>Sample 14</th>
<th>Sample 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Odor intensity</td>
<td>4.0a</td>
<td>6.4b</td>
<td>6.6b</td>
<td>7.0c</td>
</tr>
<tr>
<td>Fruit odor</td>
<td>2.2a</td>
<td>4.4b</td>
<td>4.6b</td>
<td>3.2c</td>
</tr>
<tr>
<td>Seasoning odor</td>
<td>3.8a</td>
<td>6.3b</td>
<td>6.4b</td>
<td>7.0c</td>
</tr>
<tr>
<td>Lactic odor</td>
<td>2.2a</td>
<td>2.3a</td>
<td>3.0b</td>
<td>1.5c</td>
</tr>
<tr>
<td>Aroma intensity</td>
<td>4.9a</td>
<td>6.1b</td>
<td>6.1b</td>
<td>6.2b</td>
</tr>
<tr>
<td>Fruit aroma</td>
<td>1.9a</td>
<td>4.6b</td>
<td>4.4b</td>
<td>3.1c</td>
</tr>
<tr>
<td>Seasoning aroma</td>
<td>4.3a</td>
<td>6.0b</td>
<td>5.1c</td>
<td>6.2b</td>
</tr>
<tr>
<td>Bitter</td>
<td>2.6a</td>
<td>2.0bc</td>
<td>2.5ac</td>
<td>1.8b</td>
</tr>
<tr>
<td>Acid</td>
<td>2.0a</td>
<td>3.5b</td>
<td>4.0c</td>
<td>2.0a</td>
</tr>
<tr>
<td>Piquant</td>
<td>2.9a</td>
<td>1.6b</td>
<td>1.8b</td>
<td>2.5c</td>
</tr>
<tr>
<td>Crunchy</td>
<td>7.0a</td>
<td>5.9b</td>
<td>5.1c</td>
<td>5.1c</td>
</tr>
<tr>
<td>Firmness</td>
<td>5.2a</td>
<td>3.8b</td>
<td>3.6b</td>
<td>4.8c</td>
</tr>
</tbody>
</table>

Means with the same letter are not significantly different with \( p \leq 0.5 \).
and an acid taste. The differences observed among the three different groups of samples were due to the intensity values of the fruit and seasoning odor/aroma, lactic odor, piquant and crunchy and firm texture (Table 7 and Figure 5).

It is worth mentioning that Aloreña olives are marketed until perceptible sensory defects appear. It is important to highlight the large number of traditional samples presenting sensory defects which were clearly perceptible to the panel. This was due to the way that they were prepared as the olives were kept in brine with no refrigeration, with their sensory profile evolving throughout the season, losing their fruity and green odor attributes and bitter taste and with defects appearing over time. Different alternative storage systems for preventing such changes and preserving the freshness of the olive fruits are being studied (Arroyo-López et al., 2007; Arroyo-López et al., 2008a; Arroyo-López et al., 2008b; Arroyo-López et al., 2009).

4. CONCLUSIONS

A sensory lexicon and its standard references were developed by a trained panel. The lexicon provided will help researchers to describe the sensory characteristics of other olive varieties and can be of considerable benefit to olives producers.

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