

Using trendsetting chefs to design new culinary preparations with the "Penjar" tomato

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2 Abstract

3 New food products are normally marketed after research into consumers' preferences. As
4 an alternative, we used trendsetting chefs to develop and evaluate products with the
5 traditional long shelf life "Penjar" tomato (*alc* gene). The most appreciated creations
6 were Catalan bread with tomato, tomato sauce and tomato jam, excelling by its flavor
7 complexity and balance. The description of the products by a trained panel revealed
8 significant differences between varieties (especially between the food products
9 elaborated with the "Penjar" type and conventional tomatoes). However, it was not easy
10 to match the chefs' assessments about sensory properties with the panel descriptions.

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12 Highlights

13 Trendsetting chefs prepared food elaborations using tomatoes with the *alc* gene. In their
14 opinions, some varieties and elaborations were promising. The elaborations were
15 submitted to scientific sensory analysis. Further studies are required to accommodate
16 trendsetting chefs' opinions to sensory analysis.

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18 Keywords

19 Trendsetting chefs, *alc* gene, sensory analysis, tomato, jam, Catalan bread with tomato,
20 tomato soup, tomato sauce, sensory preferences

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23 1. Introduction

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25 The design of new fresh food products (fruit, vegetables, etc.) or of transformed food
26 products (dairy products, prepared dishes, canned foods, etc.) is normally preceded by a
27 study of consumers' preferences to determine target traits (Lawless and Heyman,
28 1998). If a product seems promising, it is usually tested by a panel trained to describe its
29 main attributes. This approach makes it possible to work with objective sensory traits
30 and scales to improve both the raw material and the processes of transformation.

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This strategy requires well-planned surveys and a good sample universe, making it

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3 32 economically unfeasible for all except large companies. Thus, many local raw materials
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5 33 that are highly appreciated when consumed fresh are not transformed into new
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7 34 competitive products.

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10 35 Global communications media have helped create trendsetting references for all
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12 36 consumer products, from clothing to wine (Gaiter and Brecher, 2002; Johnson and
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14 37 Robinson, 2006; Parker, 2008) to cuisine (Michelin Travel and Lifestyle, 2010). These
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16 38 trendsetters create new alternatives that often find a place in the market through
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18 39 their creators' special talent at guessing what consumers will like. This approach to
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20 40 finding new uses for the wealth of traditional raw materials found in many places around
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22 41 the world has received little attention.

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26 42 The Alicia Foundation, whose name is derived from combining the Catalan words for
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28 43 alimentation and science, works to design new preparations to make everyday food both
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30 44 tasty and healthy. Under the direction of the prestigious chef Ferran Adrià, chefs and
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32 45 researchers (food technologists, chemists, nutritionists, etc.) work together at Alicia to
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34 46 elaborate and evaluate new dishes based on tradition and culinary research.

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38 47 The Miquel Agustí Foundation (MAF), linked to BarcelonaTech (UPC), is an
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40 48 organization in which farmers, plant breeders, chemists, and food technologists
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42 49 experienced in sensory analysis work together to recover traditional varieties that are
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44 50 appreciated for their sensory value so they can be used directly or in elaborated products.

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48 51 One product being recovered is the "Penjar" tomato, which has an average shelf life of
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50 52 more than 6 months (thanks to the *alc* gene) (Casals et al., 2011b). The "Penjar" type of
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52 53 tomato ("Penjar" means "for hanging" in Catalan) is thus named because the fruits are
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54 54 hung from the rafters under the roofs of farmhouses after harvesting. This type
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56 55 comprises a set of varieties with wide variation in agricultural characteristics,
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3 56 morphological traits, and genetic background. Furthermore, some of these varieties have,
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5 57 in different intensities, a characteristic flavor described as “sharp with floral notes”. This
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7 58 flavor increases during the first two months after harvesting and reaches its maximum
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9 59 intensity two to four months after harvesting (Casals et al., 2011a; Casals et al., 2011c).
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11 60 The intensity and type of flavors after harvesting depend on the genetic background but
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13 61 do not seem to be related with the *alc* gene. In fact, tomatoes having long shelf life
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15 62 genes different than *alc* are generally considered to lack flavor (Baldwin et al., 2000;
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17 63 Kopeliovitch et al., 1982; Kovacs et al., 2009; McGlasson et al., 1987). “Penjar”
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19 64 tomatoes are used mainly in the Mediterranean regions of Spain (the Balearic Islands,
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21 65 Catalonia, and Valencia) as well as in some regions of Italy. In Catalonia they are
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23 66 especially appreciated for preparing traditional “bread with tomato”. “Penjar” tomatoes
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25 67 are especially suitable for this dish because nearly all the tomato is transferred to the
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27 68 bread when they are rubbed on. Traditionally, the “Penjar” tomato has made it possible
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29 69 to have “fresh” tomatoes in cold seasons when it is impossible to cultivate them.
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34 70 During the research to recover this tomato, we considered that the special flavor found
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36 71 in some varieties might be used for purposes other than “bread with tomato”. The
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38 72 availability of food products derived from the “Penjar” tomato would make it possible
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40 73 to reach a wider market, and the availability of canned or otherwise preserved “Penjar”
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42 74 tomatoes would expand the period of sales beyond the current limitations (November
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44 75 through April) to encompass the entire year.
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48 76 Because “Penjar” tomatoes are grown on small farms, individual farmers do not have
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50 77 the means to carry out market studies and design transformed products. For this reason,
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52 78 the Alícia Foundation and the MAF jointly proposed to: i) have chefs develop and
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54 79 evaluate culinary preparations from diverse “Penjar” tomatoes, and ii) carry out a
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56 80 scientific sensory analysis of the chefs’ creations and relate it to chefs’ preferences so
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3 81 the relevant traits can be included in breeding programs of the “Penjar” tomato type.
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9 83 **2. Material and methods**
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12 84 *2.1. Plant material*
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15 85 Five varieties of tomato were used in the trial, including four varieties of “Penjar”
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17 86 tomato (containing the *alc* gene) selected by the MAF and one commercial variety in
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19 87 which the *alc* gene was not present:
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22 88 a) Punxa (*alc*). This variety has a pronounced nipplelike protrusion at the base of the
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24 89 fruit. Fruits are spherical, with a diameter of about 50 mm and average weight of 60 g.
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26 90 The mean yield per plant is 2634 g. This variety has very long shelf life; 91% of the
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28 91 fruit remain suitable for consumption two months after harvesting and 85% remain
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30 92 suitable for consumption after four months. The intensity of the flavor two to four
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32 93 months after harvesting is high, with earthy flavors mixed with tangy and sweet flavors.
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36 94 b) LC215 (*alc*). This variety has large, rounded though slightly flattened fruits,
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38 95 measuring 60 mm in width and 53 mm in height and weighing on average 100 g. The
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40 96 mean yield per plant is 2344 g. Approximately 70% of the fruits remain suitable for
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42 97 consumption two months after harvesting and 47% remain suitable four months after
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44 98 harvesting. The intensity of the flavor two to four months after harvesting is medium
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46 99 and dominated by earthy tones.
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51 100 c) LC209 (*alc*). This variety has fruits ranging from flattened to rounded, measuring 61
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53 101 mm in width and 46 mm in height and weighing on average 78 g. The mean yield per
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55 102 plant is 3453 g. Approximately 63% of the fruits remain suitable for consumption two
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57 103 months after harvesting and 51% remain suitable after four months. Like the variety
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3 104 LC215, the intensity of the flavor two to four months after harvesting is medium and
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5 105 dominated by earthy tones.
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8 106 d) LC401 (*alc*). This variety has considerably flattened fruits, measuring 64 mm in
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10 107 width and 47 mm in height and weighing on average 82 g. The mean yield per plant is
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12 108 2950 g. Approximately 72% of the fruits remain suitable for consumption two months
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14 109 after harvesting and 53% remain suitable after four months. The intensity of the flavor
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16 110 two to four months after harvesting is medium and dominated by earthy tones.
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20 111 e) Canary. Commercial variety of tomato chosen as representative of tomatoes with
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22 112 long shelf life that is not conferred by the *alc* gene and that do not develop new flavors
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24 113 after harvesting; these tomatoes have very firm flesh and this makes them unsuitable for
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26 114 “bread with tomato”. The fruits are rounded and large (96 g on average), the shelf life is
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28 115 short (less than one month), and flavors do not enhance after harvesting.
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33 34 35 117 2.2. *Cultivation of tomatoes for the trials*

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38 118 The “Penjar” tomatoes were cultivated in Vallès Occidental County in northeast Spain
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40 119 in alkaline loamy clay. Seedlings were transplanted May 15 and fruits were harvested in
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42 120 the red ripe stage in August. Plants received drip irrigation, fertilizer, and treatments as
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44 121 necessary to ensure they did not suffer any kind of stress. After harvesting, the fruits
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46 122 were stored in darkness at 20 ± 5 °C and 65% to 75% relative humidity for four months
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48 123 before culinary transformation and sensory evaluation.
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53 124 The Canary variety, with a limited long shelf life, was cultivated in greenhouses and
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55 125 was harvested in the red ripe stage shortly before the culinary trials.
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3 127 2.3. *Culinary preparations*
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6 128 The team of chefs at the Alicia Foundation decided to elaborate the culinary preparations
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8 129 taking care not to mask the characteristics of the raw material and applying their
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10 130 experience to highlight the particular characteristics that might interest consumers. Thus,
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12 131 the amount of accompanying substances (salt, oil, vinegar, sugar) was limited. The
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14 132 preparation “bread with tomato” was used to compare the tomatoes for their habitual use,
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16 133 without transformation. A cold tomato soup, tomato sauce, and tomato jam were
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18 134 proposed as candidates for preparations that might interest consumers. Various
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20 135 preliminary trials were carried out using commercial and experimental tomatoes to
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22 136 refine the different recipes until they were considered appropriate for the trial. All
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24 137 assessments of each preparation were done simultaneously with the same working
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26 138 conditions, time, and temperature for each replication.
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34 140 2.4. *Chefs' evaluation*
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37 141 Six chefs/researchers from the Alicia Foundation, including the ones who had prepared
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39 142 the different dishes with the tomatoes, gave their opinion about the presumable
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41 143 acceptability of the preparations to consumers. The chefs had varied ages, cultural
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43 144 backgrounds, and culinary trends. So, we consider their combined opinion a suitable
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45 145 reference about the degree of acceptability that these tomatoes might have in the market
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47 146 beyond their traditional use for making “bread with tomato”.
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52 147 The chefs openly discussed each preparation according to their usual method of working
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54 148 until they reached a consensus about the product's potential value. At the same time,
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56 149 they noted down the points and arguments in favor and against each preparation and
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58 150 each variety of tomato.
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152 *2.5. Sensory analysis*

153 A panel of 10 judges with prior experience in the sensory analysis of tomatoes (Casals
154 et al., 2011c) and of dried beans (Romero del Castillo et al., 2008) was specifically
155 trained to evaluate different culinary preparations elaborated with a wide range of
156 commercial and experimental tomatoes. This enabled the panel to choose the attributes
157 that best characterized each product and to fix the extremes of the scales.

158 A semi-structured scale ranging from 0 to 10 (Meilgaard et al., 1999) was constructed
159 for each of the attributes selected for the following products:

160 “*Bread with tomato*”: color (0=orangish-yellow, 10= maroon-red), sweetness, acidity,
161 and intensity of flavor.

162 “*Cold tomato soup*”: color, sweetness, acidity, consistency (0=liquid, 10= very dense),
163 fibrosity (0=no perceptible fibers, 10=many perceptible fibers and remains of pulp
164 and/or skin), and intensity of tomato flavor.

165 “*Tomato jam*”: color, consistency (0=liquid, 10= very jellied), sweetness, acidity,
166 intensity of aroma, intensity of flavor.

167 “*Tomato sauce*”: color, consistency (0=separation of liquid and solid, 10=consistent
168 sauce), sweetness, acidity, and intensity of flavor.

169 Given that the chefs often used the word “balance” in their descriptions, we created an
170 attribute named “balance” (which does not necessarily correspond to the same concept
171 that the chefs referred to; it is likely that the chefs’ meaning includes more aspects than
172 those strictly defined here), calculated as $(\text{sweetness} - \text{acidity})/(\text{sweetness} + \text{acidity})$.
173 The values of this attribute range from -1 to 1. Zero represents maximum balance,

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3 174 values near -1 represent a high predominance of acidity, and those near 1 represent a
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5 175 high predominance of sweetness.
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8 176 To evaluate the preparation “bread with tomato”, one slice of bread (10 cm x 5 cm x 0.8
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10 177 cm) was presented for each tomato evaluated. To evaluate the “cold tomato soup”
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12 178 preparations, 50 ml was presented in a glass. To evaluate the “tomato sauce” and
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14 179 “tomato jam” preparations, 30 g of each sample were presented in individual bowls. All
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16 180 samples were presented at room temperature (20°C) and identified with three randomly
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18 181 assigned digits.
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22 182 Each preparation was presented to the panel twice to enable statistical analysis. The
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24 183 dishes, except the “tomato jams”, were made on the day of the tasting session so they
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26 184 could be presented to the panel shortly after preparation. Overall, the trial comprised
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28 185 eight independent sessions; in each session, the panel evaluated the same preparation
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30 186 made from each of the five varieties of tomato (four different preparations x 2 sessions
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32 187 for each = 8 sessions).
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36 188 The tasting sessions took place in a room that was specially designed for sensory
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38 189 analysis (ISO International Standard 8589, 2007). To evaluate all the attributes except
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40 190 color in each preparation, the tasting cabins were illuminated with green light to mask
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42 191 the color of the samples and thus avoid the influence of visual impressions.
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46 192 We used the linear model $x_{ijk} = \mu + v_i + p_j + s_k + vp_{ij} + \varepsilon_{ijk}$ to calculate the effects for
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48 193 variety (v), panelist (p), session (s), and the interaction variety x panelist. Factors with
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50 194 an F value with $p \leq 0.05$ were considered significant.
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54 195 To make it possible to graphically compare the sensory attributes (range 0 to 10) with
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56 196 the attribute balance (range -1 to 1), each of the attributes was normalized by subtracting
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58 197 the mean of each attribute and dividing it by its standard deviation: $x_N = (x_i - \bar{x}) / SD(x)$,
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3 198 $x_N=(x_i - \bar{x})/SD(x)$. This transformation resulted in attributes centered on zero and with a
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5 199 standard deviation of 1; thus, values greater than 2 or less than -2 denote an atypical
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7 200 value for the attribute.

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10 201 The data were processed using the SAS statistical package (SAS Institute Inc., 1999).

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14 15 16 203 **3. Results**

17 18 19 204 *3.1. Culinary preparations*

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22 205 **Bread with tomato:** a) *Ingredients:* Bread (sliced cottage loaf, baked the previous day to
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24 206 provide a more compact structure for the product), tomato, salt, and refined olive oil
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26 207 (maximum acidity 0.3o) to avoid masking the flavor of the tomato with intensive olive oil
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28 208 flavor. b) *Procedure:* Wash the tomatoes, slice them in half transversely, and rub them
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30 209 over the slice of bread immediately before serving. Sprinkle salt (approximately 0.3 g)
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32 210 and dribble olive oil (approximately 5 g) over the tomato.

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37 211 **Cold tomato soup:** a) *Ingredients:* 500 g tomatoes, 100 g mineral water, 3 g salt, 50 g
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39 212 refined olive oil (maximum acidity 0.3°), 5g balsamic vinegar. b) *Procedure:* Wash the
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41 213 tomatoes and remove the peduncle. Cut them into chunks, place them in a container
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43 214 with the water, and triturate them with an immersion blender. Strain the blend of
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45 215 triturated tomatoes and water through a China cap. Season with salt, dress with the oil
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47 216 and vinegar, and emulsify with the immersion blender. Serve immediately (before the
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49 217 emulsion loses its homogeneity).

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53 218 **Tomato sauce:** a) *Ingredients:* 1250 g grated tomato, 100 g olive oil, 10 g salt. b)
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55 219 *Procedure:* Place the oil and grated tomatoes in a saucepan, add the salt, and sauté over a
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57 220 low flame for at least 2 hours until the mixture is reduced. Stir continually.

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3 221 **Tomato jam:** *a) Ingredients:* Tomatoes, sugar (50% of the weight of the prepared
4 222 tomatoes = after washing, peeling, and removing the seeds), Golden delicious apples (200
5 223 g prepared apples = cored and sliced, per 1kg of prepared tomatoes), fresh lemon juice
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7 224 (20 g per 1kg of prepared tomatoes). *b) Procedure:* Wash, scald (to facilitate the removal
8 225 of the skin), and peel the tomatoes. Cut the tomatoes into pieces, add the sugar and the
9 226 apple, and cook over a low flame. Stir well to prevent sticking and add the lemon juice.
10 227 Stir until the desired consistency is achieved. Traditionally, to know when the concoction
11 228 is ready, a few drops are dripped onto the center of a plate: if these do not slide
12 229 down when the plate is tilted, the jam is ready.
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28 231 3.2. *Evaluation by the Fundació Alicia's chefs*

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30 232 **Bread with tomato:** The chefs all agreed that the “Penjar” tomatoes were much more
31 233 suitable for rubbing on the bread than the Canary tomato (Table 1). As expected, it was
32 234 very difficult to get the flesh of the Canary tomato off the skin to adhere to the bread.
33 235 There was no consensus about the superiority of the flavors that developed in the
34 236 “Penjar” tomatoes versus those of the fresh Canary tomatoes or about the best color
35 237 (Table 1).
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44 238 **Cold tomato soups:** In general, all the concoctions have very mild tomato flavor. Those
45 239 made with “Penjar” tomatoes have particular flavors (mainly earthy tones) that do not
46 240 give the sensation of freshness that would be expected in a cold soup (Table 2). The
47 241 concoction made with fresh Canary tomatoes was recognized as clearly different,
48 242 although it was considered to lack special gastronomic potential (Table 2).
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56 243 **Tomato sauce:** The tomato sauces elaborated with “Penjar” tomatoes were considered
57 244 better than the one elaborated with fresh tomato (Table 3). The consistency of the sauce,
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1
2 245 the balance between acidity and sweetness, and the presence of complex flavors were
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4 246 considered positive, although one chef preferred the fresh flavors (Table 3).
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8 247 **Tomato jams:** Jams made with “Penjar” tomatoes were considered more aromatically
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10 248 complex and better than the one made with the fresh tomato (Table 4).
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16 250 *3.3. Results of the sensory analysis by the panel*
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19 251 **Bread with tomato:** The variety effect was significant for color and flavor (Table 5).
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21 252 There were four groups of significance for color. LC209 was the reddest and LC401 was
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23 253 the lightest (Table 5). The most intense flavor was found in LC401, Punxa, and LC209.
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25 254 Canary had the least intense flavor (Table 5).
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29 255 **Cold tomato soup:** The variety effect was significant for all traits (Table 6). The soup
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31 256 with the reddest color was made from LC209 and the soup made from LC215 was the
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33 257 least red (Table 6). The group of most acidic varieties included Punxa, LC215, and
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35 258 LC401. The variety LC209 was sweeter than the rest; no significant differences in
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37 259 sweetness were observed among the other varieties. As for the texture, the consistency
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39 260 of LC215, LC209, and Canary was thicker while Punxa and LC401 were runnier. The
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41 261 fibrosity of LC215 was greater than that of the other varieties, among which no
42
43 262 significant differences were found (Table 6). The varieties LC215 and LC209 had the
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45 263 most intense flavor (Table 6).
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50 264 **Tomato sauce:** The variety effect was significant for all the sensory attributes except
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52 265 flavor (Table 7). The tomato sauces made with LC209 and LC401 had the most intense
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54 266 red color while the sauce made from LC215 had the least intense red color (Table 7).
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56 267 The consistency of the all the sauces was greater than 5, and good cohesion between the
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58 268 liquid and solid parts was observed in all. Sauces from the varieties LC209 and Punxa had
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3 269 the thickest consistency, and those of LC215 and Canary were the less consistent (more
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5 270 watery) (Table 7). Acidity was highest in sauces made with Canary, followed by Punxa
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7 271 (Table 7). Sweetness was highest in LC401 sauce and lowest in the Canary sauce (Table
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9 272 7).

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12 273 **Tomato jam:** The variety effect was significant for all attributes except consistency and
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14 274 sweetness (Table 8). The intensity of the red color was highest in jams made from LC209
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16 275 and LC401 (Table 8). The jams made with the “Penjar” varieties were more consistent
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18 276 (thicker) than the jam made with the fresh variety (Table 8). Acidity was highest in jams
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20 277 made from Punxa or Canary and lowest in LC215. Jams made from LC215 or LC401
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22 278 were considered the most aromatic (Table 8).
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30 280 **4. Discussion**

31 32 33 281 *4.1. The culinary preparations*

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36 282 **Bread with tomato:** As expected, the “Penjar” tomato had a much better transfer
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38 283 when spread over the bread. One group of chefs preferred bread with tomato made with
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40 284 fresh tomatoes and another preferred bread with tomato made with “Penjar” tomatoes.
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42 285 The chefs paid most attention to flavor and color, and their preferences seem to be related
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44 286 with their cultural backgrounds. The panel’s sensory analysis pointed out that “Penjar”
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46 287 tomatoes have a more intense flavor than the fresh tomato and wide variation in color.
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48 288 The panel found no differences in acidity or sweetness, probably because these attributes
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50 289 are difficult to appreciate when they are combined with the characteristics of the oil and
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52 290 bread (Tables 5 and 9). It would make sense to increase the complex flavor (earthy and
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54 291 sharp) of these tomatoes as many of the chefs appreciated this characteristic. Another line
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56 292 of research would be to increase the spreading abilities of tomatoes with intense fresh
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3 293 flavor that do not have the *alc* gene to please another segment of the market.
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5 294 **Cold tomato soup:** None of the cold tomato soups was considered especially interesting
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7 295 by the chefs (Table 2). Those made from “Penjar” tomatoes were considered to have
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9 296 excessively complex flavors and the one made from fresh conventional tomatoes was
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11 297 considered to lack consistency and flavor intensity. The sensory analysis showed there are
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13 298 major differences between varieties of “Penjar” tomatoes when each trait is evaluated
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15 299 individually (Table 6). However, according to the chefs, all the “Penjar” varieties have
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17 300 significant shortcomings that must be overcome if they are to be used for this purpose
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19 301 (Table 2). The results suggest that it would be better to make cold tomato soups from
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21 302 more flavorful fresh tomatoes.
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26 303 **Tomato sauce:** The chefs’ cited the consistency, balance between acidity and
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28 304 sweetness, and presence of complex flavors as the most desirable characteristics in this
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30 305 preparation, although two of them considered that a flavor of freshness was more
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32 306 desirable than complex flavors. Punxa and LC215 were considered to best fulfill these
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34 307 criteria. In the sensory analysis (Table 7), Punxa was in the highest group of
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36 308 significance for consistency but LC215 was not. These two varieties also belong to
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38 309 different groups of significance for the balance between acidity and sweetness (Table 7).
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40 310 So, the chefs’ concepts of consistency and acid-sweet balance probably do not
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42 311 correspond to those the panelists were trained in.
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47 312 The chefs considered the “complexity of flavors” to be the most positive characteristic
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49 313 of the tomato sauce. In future studies, the panel should be trained to discriminate the
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51 314 intensities of different flavors (earthy, sharp, and others) like chefs do, and breeding
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53 315 programs should select for these traits. Moreover, the chefs’ concept of balance should
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55 316 be deeply analyzed to translate it into panel measurements useful for breeding programs.
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3 317 **Tomato jam:** The chefs also considered the jams made from “Penjar” tomatoes to be
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5 318 superior, fundamentally because they had more complex flavors. The varieties LC401
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7 319 (predominance of acidity over sweetness), LC215, and Punxa (both with good balance
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9 320 between acidity and sweetness) were considered the best because of the intensity of
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11 321 their complex flavors.

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14 322 Again, the terms the chefs used to justify their preferences were the same as those used
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16 323 by the panel but the concepts represented by these terms do not coincide. Although the
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18 324 chefs considered Punxa and LC215 to be balanced and both varieties belong to the same
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20 325 group of significance for this trait (Table 8), the panel considered the jams made from
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22 326 these varieties to be predominantly sweet (values around 0.5).
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30 328 *4.2. The varieties*

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33 329 The chefs always recognized differences between “Penjar” tomatoes and fresh
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35 330 tomatoes, pointing out the value of “Penjar” tomatoes in “bread with tomato”
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37 331 preparations (spreading capacity, together with the flavor of fresh tomatoes or with
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39 332 complex flavors, depending on the group of chefs), in tomato sauce preparations
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41 333 (consistency, balance between acidity and sweetness, complex flavor), and in tomato
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43 334 jam (balance between acidity and sweetness, complex flavor).
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47 335 The panel approach found differences between the fresh tomato and “Penjar tomatoes”,
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49 336 but, in general, the differences between the varieties of “Penjar” tomatoes that the chefs
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51 337 pointed out to justify their opinions about the products do not correspond with the
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53 338 differences that the panel detected (Tables 5, 6, 7, 8 and Figure 1).
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3 340 *4.3. The trendsetting chefs' evaluations versus the sensory panel's descriptions*

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5 341 Sensory analysis by a trained panel was not especially successful at identifying well-
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7 342 defined traits that could be related to the chefs' preferences and subsequently used for
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9 343 selection in breeding programs. It seems that the chefs consider a culinary creation as a
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11 344 whole (they make their choices by considering all the aspects together rather than by
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13 345 analyzing them individually). Although chefs sometimes talk about attributes, they do
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15 346 so without having reached a previous consensus about the definition of these attributes,
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17 347 and this contrasts sharply with the panelists' use of attributes for analysis. The chefs
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19 348 have a clear idea about what they like, but they are unaccustomed to formal analysis and
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21 349 defining descriptors to explain why they prefer one option over another.
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26 350 To accommodate the two approaches, it is essential to translate the chefs' language to
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28 351 the panelists' language. One way to accomplish this would be to train the chefs in the
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30 352 attributes and scales that the panelists use to describe the characteristics of the product;
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32 353 in this case, the two groups would share a common language and the problem would
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34 354 disappear. However, we are not convinced that this is the best way, because the chefs'
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36 355 work requires impressions derived more from synthesis than from analysis.
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44 357 **5.1 Conclusions**

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47 358 According to the chefs' proposals and evaluations some "Penjar" tomatoes are an
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49 359 excellent source for tomato sauce and tomato jam, going beyond its traditional "bread
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51 360 with tomato" use.
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55 361 Probably some consumers will not like dishes prepared with "Penjar" tomatoes as two
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57 362 of the chefs preferred the flavor of fresh tomatoes, even though the fresh tomatoes used
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3 363 were not especially flavorful. According to the other four chefs, some consumers will be
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5 364 able to appreciate the complex flavor, the balance between acidity and sweetness, and
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7 365 the color contributed by “Penjar” tomatoes.
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10 366 Although the most relevant attributes for the chefs (intensity of color, consistency of
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12 367 texture, intensity and complexity of flavor, low acidity in sauces, and high sweetness in
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14 368 jam) are fairly general in the four varieties of “Penjar”, there are differences between
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16 369 varieties that make some better than others for each preparation. Nevertheless, Punxa
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18 370 seems to be the best overall variety.
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22 371 In a short time and with little funding, our combined approach led to various creations
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24 372 that can help increase the consumption of a peculiar raw material. This is especially
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26 373 important, considering that the business around prestigious landraces is not controlled
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28 374 by large companies that can afford to invest in market studies. However, the difficulties
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30 375 of combining the two approaches are also evident. The chefs’ explanations of their
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32 376 preferences often were difficult to match with the panel’s analytical assessment.
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34 377 Although the two groups often used the same terms, it seems they were not referring to
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36 378 the same concepts. Breeding vegetables for culinary preparations requires the clear
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38 379 identification of the traits to be improved. So, if we can take advantage of trendsetting
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40 380 chefs’ abilities, additional work is necessary to analyze and translate their integrated
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42 381 preferences.
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49 50 51 383 **Acknowledgments**

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54 384 We thank the researchers at the Alícia Foundation and at the Miquel Agustí Foundation
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56 385 for their support throughout the study.
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Table 1. Synthesis of the Alicia's Foundation chefs' assessments of the "bread with tomato" preparations made with the different varieties of tomatoes.

	Punxa	LC401	LC209	LC215	Canary
Suitability for spreading	High	High	High	High	Low
Color of the "bread with tomato"	Red	Orangish-yellow	Yellowish	Dull red	Intense red
Balance	Good	Acidity predominant over sweetness	Acidity slightly greater than sweetness	Good, but low acidity and sweetness	Acidity predominant over sweetness
Flavor	Intense, different from fresh tomato. Noteworthy for sweetness, acidity, and color.	Mild and earthy, different from fresh tomato	Low	Low, but different from fresh tomato	Weak, of fresh tomato
Comments and assessment	Lack of consensus about flavors different from fresh tomatoes	Unappealing color, too many seeds, lack of consensus about flavors different from fresh tomatoes	Lacks strength, low assessment	Very watery, lacks strength, low assessment	Lack of consensus about the value of the fresh tomato flavor

Table 2. Synthesis of the Alicia's Foundation chefs' assessments of the cold tomato soup preparations made with the different varieties of tomatoes.

	Punxa	LC401	LC209	LC215	Canary
Color	Intense red	Orangish	Orangish-yellow	Orangish	Pinkish
Texture	Smooth, fine, and thick	Fine and watery	Very watery	Thick	Thick and pulpy
Balance	Good Very acidic and very sweet	Very acidic	Very acidic. Spicy.	Acidic	Good. High acidity and sweetness.
Flavor	Different from fresh tomato. Hint of ketchup.	Strong, different from fresh tomato.	Mild, different from fresh tomato.	Unremarkable. The oil component predominates.	Fresh tomato but lacking intensity
Comments and assessment	Good color for soup. Astringent aftertaste. Balanced and pleasant. Qualified as medium value.	Qualified as low value	Good flavor Color too pale, not sweet enough Qualified as medium value	Unappealing color. Mildly bitter. Qualified as low value.	Color too pink. Flavor masked by the oil. Qualified as low value.

Table 3. Synthesis of the Alicia's Foundation chefs' assessments of the tomato sauce preparations made with the different varieties of tomatoes.

	Punxa	LC401	LC209	LC215	Canary
Color	Intense red	Intense red	Intense red	Red	Red
Texture	Good consistency	Good consistency	Good consistency	Good consistency	Poor consistency
Balance	Very good	Marked acidity and low sweetness	Marked acidity and low sweetness	Good	High acidity and low sweetness
Flavor	Complex	Complex	Complex, but mild	Complex, but mild	Fresh tomato flavor
Comments and assessment	Acceptable color and flavors Qualified as high value	Unbalanced Qualified as medium value	Unbalanced Qualified as medium value	Lacking flavor Qualified as medium value	Unbalanced One chef discrepancy about the value of the complex flavors Qualified as low value

Table 4. Synthesis of the Alicia's Foundation chefs' assessments of the tomato jam preparations made with the different varieties of tomatoes.

	Punxa	LC401	LC209	LC215	Canary
Color	Red	Intense red	Intense red	Red	Dull red
Texture	Smooth	Very smooth	Smooth	Smooth	Smooth
Balance	Very balanced	Very balanced	Low acidity	Low acidity	High acidity
Flavor	Toasted + complex tomato flavors	Complex tomato flavors	Low intensity	Mostly complex tomato flavors	Candied, but not identified as tomato
Comments and assessment	Acceptable color and texture Qualified as high value	Acceptable color, texture, and flavor Qualified as high value	Qualified as medium value	Qualified as medium-to-high value	Qualified as low value

Table 5. Comparison of mean values of each variety on all the attributes in the evaluation of “bread with tomato”. Values in the same column followed by the same letter are not significantly different on the Newman-Keuls test ($p \leq 0.05$).

Variety	Color	Acidity	Sweetness	Intensity of flavor	Balance
Canary	3.96c	3.70a	4.92a	3.76c	0.141a
LC209	6.91a	4.42a	4.37a	5.27ab	0.005a
LC215	5.78b	4.19a	4.28a	4.13bc	0.012a
LC401	2.32d	3.86a	4.13a	5.35a	0.033a
Punxa	3.54c	4.69a	4.33a	4.66abc	-0.041a

Table 6. Comparison of mean values of each variety on all the attributes in the evaluation of “cold tomato soup”. Values in the same column followed by the same letter are not significantly different on the Newman-Keuls test ($p \leq 0.05$).

Variety	Color	Acidity	Sweetness	Consistency	Fibrosity	Intensity of flavor	Balance
Canary	4.06b	4.49bc	3.68b	4.15ab	3.09b	3.21b	-0.10b
LC209	7.34a	4.34c	6.11a	4.69a	2.39b	4.59a	0.17a
LC215	2.58d	5.12a	4.13b	5.02a	5.02a	5.32a	-0.11b
LC401	3.24c	5.28ab	3.91b	3.41b	2.49b	3.32b	-0.15b
Punxa	3.65bc	5.83a	3.84b	3.49b	2.41b	2.94b	-0.21b

Table 7. Comparison of the mean values of each variety on all the attributes in the evaluation of “tomato sauce”. Values in the same column followed by the same letter are not significantly different on the Newman-Keuls test ($p \leq 0.05$).

Variety	Color	Consistency	Acidity	Sweetness	Intensity of flavor	Balance
Canary	4.84bc	5.63c	8.39a	2.29d	5.63a	-0.567c
LC209	8.04a	7.18a	5.12c	3.51c	5.21a	-0.247b
LC215	4.19c	5.71c	4.56c	4.64b	4.62a	0.033a
LC401	7.47a	6.30b	4.71c	5.91a	5.42a	0.126a
Punxa	5.37b	6.67ab	7.27b	2.96cd	4.96a	-0.452c

Table 8. Comparison of the mean values of each variety on in the evaluation of “tomato jam”. Values in the same column followed by the same letter are not significantly different on the Newman-Keuls test ($p \leq 0.05$).

Variety	Color	Consistency	Acidity	Sweetness	Intensity of aroma	Intensity of flavor	Balance
Canary	4.45b	5.59b	3.25a	6.88b	3.04bc	2.78b	0.36b
LC209	7.30a	6.24ab	2.29bc	7.05b	3.03bc	3.25ab	0.51ab
LC215	5.07b	5.95ab	1.95c	7.95a	3.98a	3.87a	0.61a
LC401	7.04a	6.49a	2.56b	6.76b	3.92ab	3.83a	0.45ab
Punxa	5.15b	6.21ab	3.33a	7.34ab	2.67c	3.07ab	0.38ab

Table 9. Comparison of the mean value of the Penjar varieties with the fresh variety used as a check for the different preparations and attributes.

Preparation	Genotype	Color	Texture	Acidity	Sweetness	Flavor	Balance
Bread with tomato	Penjar mean	4.63a	.	4.30a	4.26a	4.85a	-0.01a
	Canary	3.96a	.	3.71a	4.89a	3.76b	0.14a
Cold tomato soup	Penjar mean	4.19a	4.15a	5.14a	4.50a	4.04a	-0.07a
	Canary	4.05a	4.15a	4.49a	3.68b	3.21a	-0.10a
Tomato sauce	Penjar mean	6.26a	6.46a	5.41a	4.25a	5.05a	-0.12a
	Canary	4.84b	5.63b	8.39b	2.29a	5.63a	-0.57b
Tomato jam	Penjar mean	6.14a	6.22a	2.53a	7.26a	3.50a	0.48a
	Canary	4.45b	5.59b	3.25b	6.88b	2.78b	0.36b

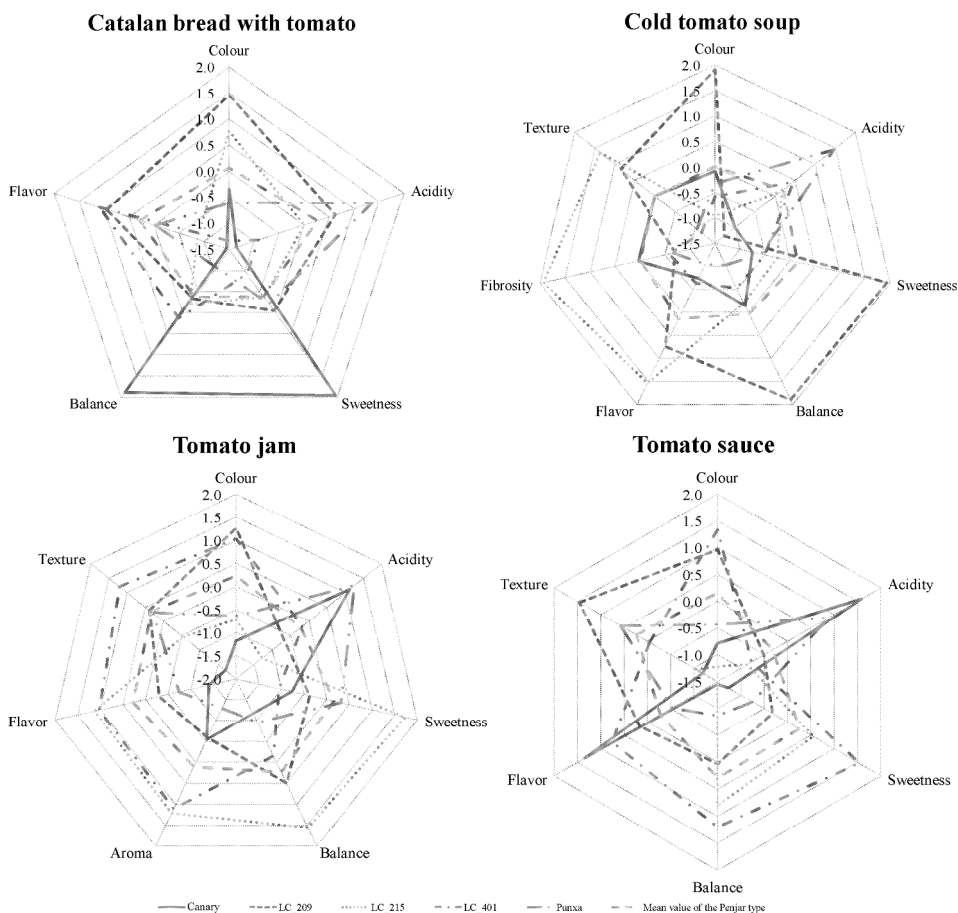


Figure 1
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Figure 1. Radar charts for all the preparations, with the standardized data, and in each preparation the five varieties plus another entry representing the mean of the four “Penjar” varieties.

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