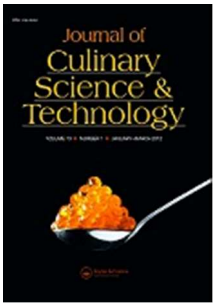

Using trendsetting chefs to design new culinary preparations with the "Penjar" tomato

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Abstract

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

Highlights

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

Keywords

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

1. Introduction

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

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

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

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

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

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

One product being recovered is the "Penjar" tomato, which has an average shelf life of more than 6 months (thanks to the *alc* gene) (Casals et al., 2011b). The "Penjar" type of tomato ("Penjar" means "for hanging" in Catalan) is thus named because the fruits are hung from the rafters under the roofs of farmhouses after harvesting. This type comprises a set of varieties with wide variation in agricultural characteristics,

morphological traits, and genetic background. Furthermore, some of these varieties have, in different intensities, a characteristic flavor described as "sharp with floral notes". This flavor increases during the first two months after harvesting and reaches its maximum intensity two to four months after harvesting (Casals et al., 2011a; Casals et al., 2011c). The intensity and type of flavors after harvesting depend on the genetic background but do not seem to be related with the *alc* gene. In fact, tomatoes having long shelf life genes different than *alc* are generally considered to lack flavor (Baldwin et al., 2000; Kopeliovitch et al., 1982; Kovacs et al., 2009; McGlasson et al., 1987). "Penjar" tomatoes are used mainly in the Mediterranean regions of Spain (the Balearic Islands, Catalonia, and Valencia) as well as in some regions of Italy. In Catalonia they are especially appreciated for preparing traditional "bread with tomato". "Penjar" tomatoes are especially suitable for this dish because nearly all the tomato is transferred to the bread when they are rubbed on. Traditionally, the "Penjar" tomato has made it possible to have "fresh" tomatoes in cold seasons when it is impossible to cultivate them.

During the research to recover this tomato, we considered that the special flavor found in some varieties might be used for purposes other than "bread with tomato". The availability of food products derived from the "Penjar" tomato would make it possible to reach a wider market, and the availability of canned or otherwise preserved "Penjar" tomatoes would expand the period of sales beyond the current limitations (November through April) to encompass the entire year.

Because "Penjar" tomatoes are grown on small farms, individual farmers do not have the means to carry out market studies and design transformed products. For this reason, the Alícia Foundation and the MAF jointly proposed to: i) have chefs develop and evaluate culinary preparations from diverse "Penjar" tomatoes, and ii) carry out a scientific sensory analysis of the chefs' creations and relate it to chefs' preferences so

the relevant traits can be included in breeding programs of the "Penjar" tomato type.

2. Material and methods

2.1. Plant material

Five varieties of tomato were used in the trial, including four varieties of "Penjar" tomato (containing the *alc* gene) selected by the MAF and one commercial variety in which the *alc* gene was not present:

a) Punxa (*alc*). This variety has a pronounced nipplelike protrusion at the base of the fruit. Fruits are spherical, with a diameter of about 50 mm and average weight of 60 g. The mean yield per plant is 2634 g. This variety has very long shelf life; 91% of the fruit remain suitable for consumption two months after harvesting and 85% remain suitable for consumption after four months. The intensity of the flavor two to four months after harvesting is high, with earthy flavors mixed with tangy and sweet flavors.

b) LC215 (*alc*). This variety has large, rounded though slightly flattened fruits, measuring 60 mm in width and 53 mm in height and weighing on average 100 g. The mean yield per plant is 2344 g. Approximately 70% of the fruits remain suitable for consumption two months after harvesting and 47% remain suitable four months after harvesting. The intensity of the flavor two to four months after harvesting is medium and dominated by earthy tones.

c) LC209 (*alc*). This variety has fruits ranging from flattened to rounded, measuring 61 mm in width and 46 mm in height and weighing on average 78 g. The mean yield per plant is 3453 g. Approximately 63% of the fruits remain suitable for consumption two months after harvesting and 51% remain suitable after four months. Like the variety

LC215, the intensity of the flavor two to four months after harvesting is medium and dominated by earthy tones.

d) LC401 (*alc*). This variety has considerably flattened fruits, measuring 64 mm in width and 47 mm in height and weighing on average 82 g. The mean yield per plant is 2950 g. Approximately 72% of the fruits remain suitable for consumption two months after harvesting and 53% remain suitable after four months. The intensity of the flavor two to four months after harvesting is medium and dominated by earthy tones.

e) Canary. Commercial variety of tomato chosen as representative of tomatoes with long shelf life that is not conferred by the *alc* gene and that do not develop new flavors after harvesting; these tomatoes have very firm flesh and this makes them unsuitable for "bread with tomato". The fruits are rounded and large (96 g on average), the shelf life is short (less than one month), and flavors do not enhance after harvesting.

2.2. Cultivation of tomatoes for the trials

The "Penjar" tomatoes were cultivated in Vallès Occidental County in northeast Spain in alkaline loamy clay. Seedlings were transplanted May 15 and fruits were harvested in the red ripe stage in August. Plants received drip irrigation, fertilizer, and treatments as necessary to ensure they did not suffer any kind of stress. After harvesting, the fruits were stored in darkness at 20 ± 5 ºC and 65% to 75% relative humidity for four months before culinary transformation and sensory evaluation.

The Canary variety, with a limited long shelf life, was cultivated in greenhouses and was harvested in the red ripe stage shortly before the culinary trials.

2.3. *Culinary preparations*

The team of chefs at the Alícia Founation decided to elaborate the culinary preparations taking care not to mask the characteristics of the raw material and applying their experience to highlight the particular characteristics that might interest consumers. Thus, the amount of accompanying substances (salt, oil, vinegar, sugar) was limited. The preparation "bread with tomato" was used to compare the tomatoes for their habitual use, without transformation. A cold tomato soup, tomato sauce, and tomato jam were proposed as candidates for preparations that might interest consumers. Various preliminary trials were carried out using commercial and experimental tomatoes to refine the different recipes until they were considered appropriate for the trial. All assessments of each preparation were done simultaneously with the same working conditions, time, and temperature for each replication.

2.4. *Chefs' evaluation*

Six chefs/researchers from the Alícia Foundation, including the ones who had prepared the different dishes with the tomatoes, gave their opinion about the presumable acceptability of the preparations to consumers. The chefs had varied ages, cultural backgrounds, and culinary trends. So, we consider their combined opinion a suitable reference about the degree of acceptability that these tomatoes might have in the market beyond their traditional use for making "bread with tomato".

The chefs openly discussed each preparation according to their usual method of working until they reached a consensus about the product's potential value. At the same time, they noted down the points and arguments in favor and against each preparation and each variety of tomato.

2.5. *Sensory analysis*

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

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

"Bread with tomato": color (0=orangish-yellow, 10= maroon-red), sweetness, acidity, and intensity of flavor.

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

"Tomato jam": color, consistency (0=liquid, 10= very jellied), sweetness, acidity, intensity of aroma, intensity of flavor.

"Tomato sauce": color, consistency (0=separation of liquid and solid, 10=consistent sauce), sweetness, acidity, and intensity of flavor.

Given that the chefs often used the word "balance" in their descriptions, we created an attribute named "balance" (which does not necessarily correspond to the same concept that the chefs referred to; it is likely that the chefs' meaning includes more aspects than those strictly defined here), calculated as (sweetness - acidity)/(sweetness + acidity). The values of this attribute range from -1 to 1. Zero represents maximum balance,

values near -1 represent a high predominance of acidity, and those near 1 represent a high predominance of sweetness.

To evaluate the preparation "bread with tomato", one slice of bread (10 cm x 5 cm x 0.8 cm) was presented for each tomato evaluated. To evaluate the "cold tomato soup" preparations, 50 ml was presented in a glass. To evaluate the "tomato sauce" and "tomato jam" preparations, 30 g of each sample were presented in individual bowls. All samples were presented at room temperature (20ºC) and identified with three randomly assigned digits.

Each preparation was presented to the panel twice to enable statistical analysis. The dishes, except the "tomato jams", were made on the day of the tasting session so they could be presented to the panel shortly after preparation. Overall, the trial comprised eight independent sessions; in each session, the panel evaluated the same preparation made from each of the five varieties of tomato (four different preparations x 2 sessions for each = 8 sessions).

The tasting sessions took place in a room that was specially designed for sensory analysis (ISO International Standard 8589, 2007). To evaluate all the attributes except color in each preparation, the tasting cabins were illuminated with green light to mask the color of the samples and thus avoid the influence of visual impressions.

We used the linear model $x_{ijk} = \mu + v_i + p_j + s_k + vp_{ij} + \varepsilon_{ijk}$ to calculate the effects for variety (v), panelist (p), session (s), and the interaction variety x panelist. Factors with an F value with $p \leq 0.05$ were considered significant.

To make it possible to graphically compare the sensory attributes (range 0 to 10) with the attribute balance (range -1 to 1), each of the attributes was normalized by subtracting the mean of each attribute and dividing it by its standard deviation: $x_N = (x_i - x) \,/\, SD(x)$,

$x_N=(x_i - x)/SD(x)$. This transformation resulted in attributes centered on zero and with a standard deviation of 1; thus, values greater than 2 or less than -2 denote an atypical value for the attribute.

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

3. Results

3.1. Culinary preparations

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

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

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

Tomato jam: *a) Ingredients:* Tomatoes, sugar (50% of the weight of the prepared tomatoes = after washing, peeling, and removing the seeds), Golden delicious apples (200 g prepared apples = cored and sliced, per 1kg of prepared tomatoes), fresh lemon juice (20 g per 1kg of prepared tomatoes). *b) Procedure:* Wash, scald (to facilitate the removal of the skin), and peel the tomatoes. Cut the tomatoes into pieces, add the sugar and the apple, and cook over a low flame. Stir well to prevent sticking and add the lemon juice. Stir until the desired consistency is achieved. Traditionally, to know when the concoction is ready, a few drops are dripped onto the center of a plate: if these do not slide down when the plate is tilted, the jam is ready.

3.2. Evaluation by the Fundació Alícia's chefs

Bread with tomato: The chefs all agreed that the "Penjar" tomatoes were much more suitable for rubbing on the bread than the Canary tomato (Table 1). As expected, it was very difficult to get the flesh of the Canary tomato off the skin to adhere to the bread. There was no consensus about the superiority of the flavors that developed in the "Penjar" tomatoes versus those of the fresh Canary tomatoes or about the best color (Table 1).

Cold tomato soups: In general, all the concoctions have very mild tomato flavor. Those made with "Penjar" tomatoes have particular flavors (mainly earthy tones) that do not give the sensation of freshness that would be expected in a cold soup (Table 2). The concoction made with fresh Canary tomatoes was recognized as clearly different, although it was considered to lack special gastronomic potential (Table 2).

Tomato sauce: The tomato sauces elaborated with "Penjar" tomatoes were considered better than the one elaborated with fresh tomato (Table 3). The consistency of the sauce,

the balance between acidity and sweetness, and the presence of complex flavors were considered positive, although one chef preferred the fresh flavors (Table 3).

Tomato jams: Jams made with "Penjar" tomatoes were considered more aromatically complex and better than the one made with the fresh tomato (Table 4).

3.3. Results of the sensory analysis by the panel

Bread with tomato: The variety effect was significant for color and flavor (Table 5). There were four groups of significance for color. LC209 was the reddest and LC401 was the lightest (Table 5). The most intense flavor was found in LC401, Punxa, and LC209. Canary had the least intense flavor (Table 5).

Cold tomato soup: The variety effect was significant for all traits (Table 6). The soup with the reddest color was made from LC209 and the soup made from LC215 was the least red (Table 6). The group of most acidic varieties included Punxa, LC215, and LC401. The variety LC209 was sweeter than the rest; no significant differences in sweetness were observed among the other varieties. As for the texture, the consistency of LC215, LC209, and Canary was thicker while Punxa and LC401 were runnier. The fibrosity of LC215 was greater than that of the other varieties, among which no significant differences were found (Table 6). The varieties LC215 and LC209 had the most intense flavor (Table 6).

Tomato sauce: The variety effect was significant for all the sensory attributes except flavor (Table 7). The tomato sauces made with LC209 and LC401 had the most intense red color while the sauce made from LC215 had the least intense red color (Table 7). The consistency of the all the sauces was greater than 5, and good cohesion between the liquid and solid parts was observed in all. Sauces from the varieties LC209 and Punxa had

the thickest consistency, and those of LC215 and Canary were the less consistent (more watery) (Table 7). Acidity was highest in sauces made with Canary, followed by Punxa (Table 7). Sweetness was highest in LC401 sauce and lowest in the Canary sauce (Table 7).

Tomato jam: The variety effect was significant for all attributes except consistency and sweetness (Table 8). The intensity of the red color was highest in jams made from LC209 and LC401 (Table 8). The jams made with the "Penjar" varieties were more consistent (thicker) than the jam made with the fresh variety (Table 8). Acidity was highest in jams made from Punxa or Canary and lowest in LC215. Jams made from LC215 or LC401 were considered the most aromatic (Table 8).

4. Discussion

4.1. The culinary preparations

Bread with tomato: As expected, the "Penjar" tomato had a much better transfer when spread over the bread. One group of chefs preferred bread with tomato made with fresh tomatoes and another preferred bread with tomato made with "Penjar" tomatoes. The chefs paid most attention to flavor and color, and their preferences seem to be related with their cultural backgrounds. The panel's sensory analysis pointed out that "Penjar" tomatoes have a more intense flavor than the fresh tomato and wide variation in color. The panel found no differences in acidity or sweetness, probably because these attributes are difficult to appreciate when they are combined with the characteristics of the oil and bread (Tables 5 and 9). It would make sense to increase the complex flavor (earthy and sharp) of these tomatoes as many of the chefs appreciated this characteristic. Another line of research would be to increase the spreading abilities of tomatoes with intense fresh

flavor that do not have the *alc* gene to please another segment of the market.

Cold tomato soup: None of the cold tomato soups was considered especially interesting by the chefs (Table 2). Those made from "Penjar" tomatoes were considered to have excessively complex flavors and the one made from fresh conventional tomatoes was considered to lack consistency and flavor intensity. The sensory analysis showed there are major differences between varieties of "Penjar" tomatoes when each trait is evaluated individually (Table 6). However, according to the chefs, all the "Penjar" varieties have significant shortcomings that must be overcome if they are to be used for this purpose (Table 2). The results suggest that it would be better to make cold tomato soups from more flavorful fresh tomatoes.

Tomato sauce: The chefs' cited the consistency, balance between acidity and sweetness, and presence of complex flavors as the most desirable characteristics in this preparation, although two of them considered that a flavor of freshness was more desirable than complex flavors. Punxa and LC215 were considered to best fulfill these criteria. In the sensory analysis (Table 7), Punxa was in the highest group of significance for consistency but LC215 was not. These two varieties also belong to different groups of significance for the balance between acidity and sweetness (Table 7). So, the chefs' concepts of consistency and acid-sweet balance probably do not correspond to those the panelists were trained in.

The chefs considered the "complexity of flavors" to be the most positive characteristic of the tomato sauce. In future studies, the panel should be trained to discriminate the intensities of different flavors (earthy, sharp, and others) like chefs do, and breeding programs should select for these traits. Moreover, the chefs' concept of balance should be deeply analyzed to translate it into panel measurements useful for breeding programs.

Tomato jam: The chefs also considered the jams made from "Penjar" tomatoes to be superior, fundamentally because they had more complex flavors. The varieties LC401 (predominance of acidity over sweetness), LC215, and Punxa (both with good balance between acidity and sweetness) were considered the best because of the intensity of their complex flavors.

Again, the terms the chefs used to justify their preferences were the same as those used by the panel but the concepts represented by these terms do not coincide. Although the chefs considered Punxa and LC215 to be balanced and both varieties belong to the same group of significance for this trait (Table 8), the panel considered the jams made from these varieties to be predominantly sweet (values around 0.5).

4.2. The varieties

The chefs always recognized differences between "Penjar" tomatoes and fresh tomatoes, pointing out the value of "Penjar" tomatoes in "bread with tomato" preparations (spreading capacity, together with the flavor of fresh tomatoes or with complex flavors, depending on the group of chefs), in tomato sauce preparations (consistency, balance between acidity and sweetness, complex flavor), and in tomato jam (balance between acidity and sweetness, complex flavor).

The panel approach found differences between the fresh tomato and "Penjar tomatoes", but, in general, the differences between the varieties of "Penjar" tomatoes that the chefs pointed out to justify their opinions about the products do not correspond with the differences that the panel detected (Tables 5, 6, 7, 8 and Figure 1).

4.3. The trendsetting chefs' evaluations versus the sensory panel's descriptions

Sensory analysis by a trained panel was not especially successful at identifying well-defined traits that could be related to the chefs' preferences and subsequently used for selection in breeding programs. It seems that the chefs consider a culinary creation as a whole (they make their choices by considering all the aspects together rather than by analyzing them individually). Although chefs sometimes talk about attributes, they do so without having reached a previous consensus about the definition of these attributes, and this contrasts sharply with the panelists' use of attributes for analysis. The chefs have a clear idea about what they like, but they are unaccustomed to formal analysis and defining descriptors to explain why they prefer one option over another.

To accommodate the two approaches, it is essential to translate the chefs' language to the panelists' language. One way to accomplish this would be to train the chefs in the attributes and scales that the panelists use to describe the characteristics of the product; in this case, the two groups would share a common language and the problem would disappear. However, we are not convinced that this is the best way, because the chefs' work requires impressions derived more from synthesis than from analysis.

5.1 Conclusions

According to the chefs' proposals and evaluations some "Penjar" tomatoes are an excellent source for tomato sauce and tomato jam, going beyond its traditional "bread with tomato" use.

Probably some consumers will not like dishes prepared with "Penjar" tomatoes as two of the chefs preferred the flavor of fresh tomatoes, even though the fresh tomatoes used

were not especially flavorful. According to the other four chefs, some consumers will be able to appreciate the complex flavor, the balance between acidity and sweetness, and the color contributed by "Penjar" tomatoes.

Although the most relevant attributes for the chefs (intensity of color, consistency of texture, intensity and complexity of flavor, low acidity in sauces, and high sweetness in jam) are fairly general in the four varieties of "Penjar", there are differences between varieties that make some better than others for each preparation. Nevertheless, Punxa seems to be the best overall variety.

In a short time and with little funding, our combined approach led to various creations that can help increase the consumption of a peculiar raw material. This is especially important, considering that the business around prestigious landraces is not controlled by large companies that can afford to invest in market studies. However, the difficulties of combining the two approaches are also evident. The chefs' explanations of their preferences often were difficult to match with the panel's analytical assessment. Although the two groups often used the same terms, it seems they were not referring to the same concepts. Breeding vegetables for culinary preparations requires the clear identification of the traits to be improved. So, if we can take advantage of trendsetting chefs' abilities, additional work is necessary to analyze and translate their integrated preferences.

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Table 1. Synthesis of the Alícia'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 Alícia'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 Alícia'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 Alícia'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

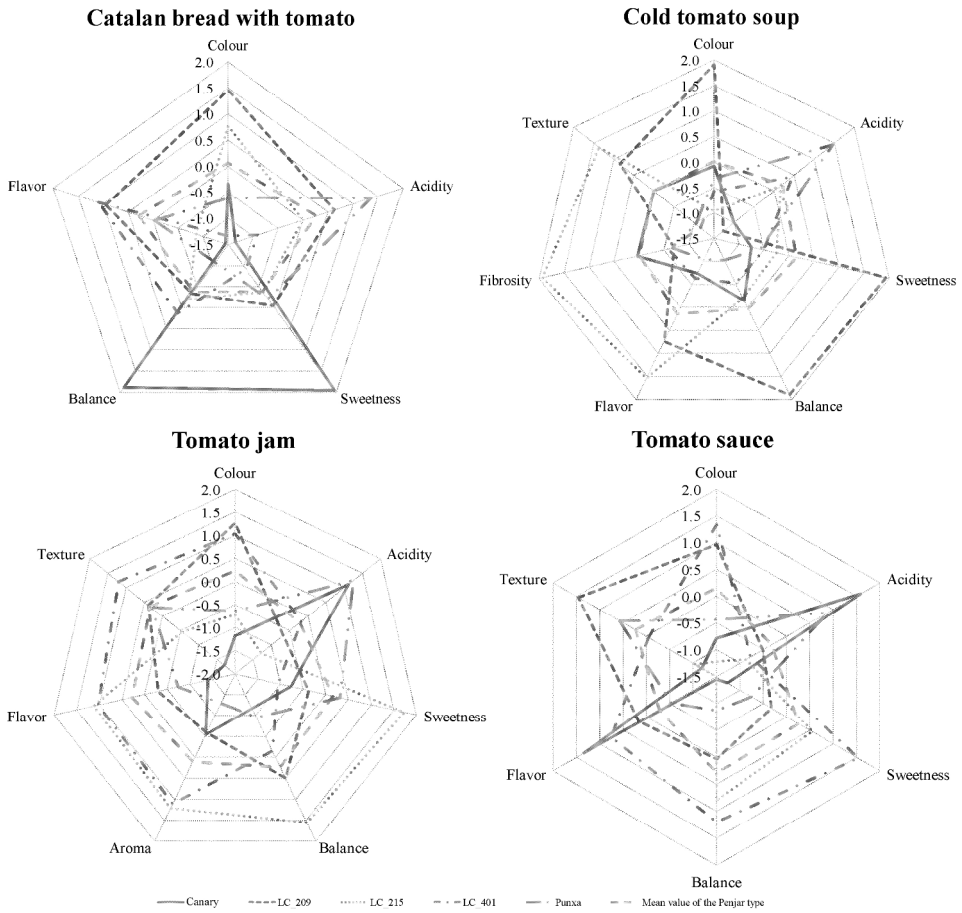

Figure 1
846x793mm (96 x 96 DPI)

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.