POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

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Pol. J. Food Nutr. Sci.
2007, Vol. 57, No. 4(A), pp. 71-76

# APPLICATION OF SENSORY EVALUATION OF FOOD TO QUALITY CONTROL IN THE SPANISH FOOD INDUSTRY

*Ángel A. Carbonell-Barrachina*

*Department of AgroFood Technology, Miguel Hernández University, Alicante, Spain*

Key words: almond; chocolate; honey; ice-cream turrón; virgin olive oil

Sensory evaluation of food is a growing science, which is of particular interest for typical products such as those having a Protected Designation of Origin (PDO). The fields of application are quite diversified, and include basic and specific characterization of the various typologies within the PDO areas, research of market sector preferences, quality control, instrumental technique verification, and the protection of "typicity" against imitations. This manuscript will concentrate mainly on two products: (a) virgin olive oil and (b) *turrón*. Virgin olive oil will be used as the model to imitate by other products in Spain, for example *turrón*. The International Olive Oil Council (IOOC) is the organism dedicated to look after the quality of virgin olive oil, which was the first food in Spain incorporating sensory criteria in its commercial classification. The IOOC provides readers with all information required to scientifically carry out sensory evaluation of olive oils. Jijona and Alicante *turrón* (semi-solid and solid products, respectively) are typical Spanish confectionery products made from toasted almonds, sugars and honey and manufactured in a traditional way. Up to date, *turrón* is commercially classified according to its almond content; however, this commercial classification does not ensure consumer with a high quality product. Now, the Regulating Council of the Specific Denominations Jijona and Alicante *Turrón* is working in the incorporation of sensory evaluation as the second quality criteria for its commercial classification, following the example of virgin olive oil.

## INTRODUCTION

Sensory tests, of course, have been conducted for as long as there have been human beings evaluating the goodness or badness of food, water, and everything else that can be used and consumed [Meilgaard *et al*., 1999]. The rise of trading inspired slightly more formal sensory testing. Nowadays, scientists have developed sensory testing, then very recently as a formalized, structured, and codified methodology, and they continue to develop new methods and refine existing ones. Sensory testing can establish the worth of a food or even its very acceptability. The main uses of sensory techniques are in quality control, product development, and research [Meilgaard *et al*., 1999] and are represented in Figure 1.

Sensory evaluation is starting to be incorporated in many food companies in Spain. However, its inclusion depends mainly in the size of the company. For instance, if we go to big companies such as Puleva Biotech S.A., you will find them using sensory evaluation every day in several of their departments: (a) quality control, (b) research and development, and (c) marketing. However, small companies do not have the structure, personnel, and/or qualification to run these analyses, even though they are aware of its interest. So, those companies having medium size are those who are trying to incorporate sensory evaluation as one modern tool to improve their efficiency and of course income.

This short review will try to show the current use of sensory techniques in two traditional Spanish products, virgin olive oil and *turrón*. Virgin olive oil companies are gathered around the International Olive Oil Council since 1956 and they use sensory techniques to find what makes a specific olive oil different from the others (Origin Denominations), check the quality of their products and establish their commercial categories. Virgin olive oils are produce throughout Spain and it is a very important food item. On the other hand, *turrón* is also a traditional food but its production is limited to one town in the Alicante province, Jijona. Companies elaborating

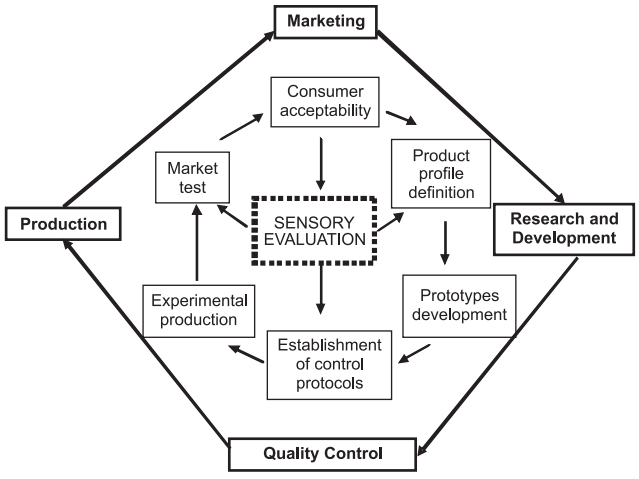


FIGURE 1. Role of sensory evaluation within a food industry with well structured departments.

Author's address for correspondence: Professor Ángel A. Carbonell-Barrachina, Miguel Hernández University, Department of AgroFood Technology, Carretera Beniel, km 3.2, 03312-Orihuela, Alicante, Spain; e-mail: angel.carbonell@umh.es

*turrón* are small or medium sized and, in general, they do not have specialized staff to train and control sensory panels, and design sensory tests, even though the biggest companies are working on it. However, they still have a long way to go and in this review virgin olive oil is proposed as the model to follow for those Spanish traditional foods willing to introduce sensory techniques in their production systems.

Traditional foods are often related to local foods and artisan foods referring to specific ingredients, location of the production and know-how. Alicante and Jijona *turrón* are a clear example of traditional food [Cayot, 2007]. Different questions arise when reproducing these foods in an industrial scale, and sensory techniques can help food companies to answer some of these questions: (1) Is it possible to find the ingredients in enough amounts and quality to cover the current demand of foods? (2) Is it possible to reproduce the recipe and the traditional process? (3) Could it be as good as it was? Could it be better from a sensory point of view? (4) Could it be healthier? Is it possible to add some functional ingredient without losing sensory quality? and fianly (5) Is it possible to find what makes the specificity of these products and make the consumer aware of this typicality?

## VIRGIN OLIVE OIL

Olive oil is an important cooking oil used extensively in Europe and the Americas. It is an integral part of the cultural and culinary heritage of the Mediterranean countries (Spain, Italy, Greece, *etc*.) and a product that is set apart by its organoleptic and nutritional qualities. Spain is the main world producer of olive oil; in the 2001/2002 crop year (November 1-October 31), Spain produced a total of 1.411.400 t out of 2.463.700 t produced by the European Union and 2.825.500 t produced worldwide [IOOC, 2007]. In addition, Spain is the second highest consumer of olive oil (631.200 t, 33.3% of the total EU consumption) only behind Italy (735.000 t, 38.8%); the world and EU consumptions for the season 2001/2002 were 2.601.500 and 1.893.800 t, respectively [IOOC, 2007].

There are several types of olive oils (extra virgin, virgin, or just "olive oil") available in world supermarkets. Extra virgin olive oil is made directly from olives without any chemical treatments. Sometimes, due to unfavorable climate conditions or deficiencies in the production process, virgin olive oils have a high degree of acidity and/or defective flavor, color, or aroma. These oils, called "*lampante* virgin oils", must undergo a refining process to correct these defects. This is how "refined olive oil" is obtained, a product that maintains the chemical structure of olive oil but does not have any aroma or flavor. This product is not marketable, but a certain quantity of extra virgin, virgin, or ordinary virgin olive oil is added to the oil to give it some aroma and flavor to obtain the commercial category called "olive oil". Refining techniques, including caustic-refining, bleaching, and deodorizing, adsorption, and membrane filtration, could reduce the color, unpleasant flavor, and content of free fatty acids in various edible oils. Unfortunately, some of the refining processes have been reported to decrease the contents of natural antioxidants such as tocopherols and oryzanols [Fullana *et al.*, 2004].

The creation of the *International Olive Oil Council,* as a consequence of the entry into force of the 1956 International Olive Oil Agreement, was a true act of faith [IOOC, 2007]. By coordinating national production and marketing policies for olive oils and table olives, adopting rules and standards to ensure product authenticity and implementing multidisciplinary activities in the fields of agriculture, technology, science and information, the Council has become the linchpin of any multilateral activity aimed at defending and promoting the olive tree and its produce.

The fact is that the prestige of olive oil is growing stronger by the day far beyond its Mediterranean borders, which augurs a new lease of life for this age-old tree and encourages the entire olive community to continue working for all those who earn their livelihood from olive farming.

With this in mind a set of provisions have been written and are designed to ensure regular trading operations, not just for reasons of legality but also of economic stability. This is done by the adoption of a series of provisions and principles such as designations (names) and definitions for olive oils, olive-pomace oils and table olives as well as indications of source and designations of origin.

International standardisation is a way of ensuring that the methods of analysis and control used on this basis cannot be questioned. At the same time it helps to avoid arbitration disputes between users of different standards. It therefore undeniably contributes to providing guarantees in international trade relations. Besides, methods of analysis have to be regularly adapted to reflect developments and breakthroughs in olive oil chemistry and sensory analysis. All of this is a task the Council accepts fully.

The food and trade standards which make possible to guarantee consumers high quality oil. When it comes to trade relations, they help to prevent and control various types of fraud and adulteration that could discredit the product and disrupt the balance on the international market.

Finally, generic promotion has always been an excellent tool for expanding world consumption of olive products as part of the policy of achieving regular, balanced international markets for olive products. The promotional strategy of the Council is based on three key lines of action, which are: to conduct scientific research into the biological value of olive oil and to disseminate research findings as widely as possible; to inform and educate consumers; and to build up effective international cooperation.

Many variables must be controlled if he results of a sensory test are to measure the true product differences under investigation. It is convenient to group these variables under three major headings [Meilgaard *et al.*, 1999]:

**Test controls.** The test room environment, the use of booths or a round table, the lighting, the room air, the preparation area, the entry and exit areas.

**Product controls.** The equipment used, the way samples are screened, prepared, numbered, coded, and served.

**Panel controls.** The procedure to be used by a panelist evaluating the sample in question.

The IOO Council provides their members with all necessary information to carry out this task scientifically. Some

documents provided by the Council related to sensory evaluation of olive oils are:

**General basic vocabulary** [COI/T.20/Doc. no. 4; 18 June 1987]: the purpose of this standard is to assemble the general terms used in sensory analysis and to give their definitions. This document is divided into sections: (a) general terminology (acceptability, aspect, *etc.*), (b) physiological terms (adaptation, contrast effect, *etc.*), and (c) terminology related to organoleptic attributes (acid, aroma, *etc.*).

**Glass for oil tasting** [COI/T.20/Doc. no. 5; 18 June 1987]: the purpose of this standard is to describe the characteristics of the glass intended for use in the organoleptic analysis of edible oils (odor, taste, flavor). In addition, it describes the adapted heating unit needed to reach and maintain the right temperature for this analysis.

**Guide for the installation of a test room** [COI/T.20/Doc. no. 6; 19 June 1987]: the test room is designed to provide the panel participating in the sensory tests with a suitable, comfortable, standardized environment which facilitates work and helps to improve the repeatability and reproducibility of the results.

**General methodology for the organoleptic assessment of virgin olive oil** [COI/T.20/Doc. no.13/Rev. 1; 20 November 1996]: The purpose of this standard is to stipulate the prior knowledge required to perform the sensory analysis of virgin olive oils, to standardize the conduct of, and procedure followed by, the tasters participating in such tests and to specify the duties of the panel supervisor.

**Guide for the selection, training and monitoring of skilled virgin olive oil tasters** [COI/T.20/Doc. no. 14/Rev. 1; 20 November 1996]: The purpose of this standard is to provide panel supervisors with essential rules for selecting, training and monitoring the selected tasters on their panel.

**Organoleptic assessment of virgin olive oil** [COI/T.20/Doc. no. 15/Rev. 1; 20 November 1996]: The purpose of this international method is to determine the criteria needed to assess the flavor characteristics of virgin olive oil and to develop the methodology for its classification.

According to this last standard, the olive oil shall be classified in: (1) the *extra virgin* grade when the median of the defects is equal to 0 and the median of the fruity attribute is more than 0; (2) the *virgin* grade when the median of the defects is more than 0 and less than or equal to 2.5 and the median of the fruity attribute is more than 0; (3) the *ordinary virgin* grade when the median of the defects is more than 2.5 and less than or equal to 6.0 or when the median of the defects is less than or equal to 2.5 and the median of the fruity attribute is equal to 0; and (4) the *lampante virgin* grade when the median of the defects is more than 6.0.

The use of sensory evaluation as a method for classifying the olive oil into commercial categories is which makes different olive oil from other foods, which uses this science for approaching their product to consumers, such as cheese and specially wine.

## *TURRÓN*

Alicante and Jijona *turrón* are typical Spanish confectionery products made from toasted almonds, sugar, inverted sugar and honey and manufactured in a traditional way as shown in Figure 2. Both almonds and honey must be from Eastern Spain and are the key ingredients of this confectionery dessert. Sucrose, honey, and water are placed in a boiler-pan and homogenized with an anchor impeller. The syrup is concentrated to approximately 80oBrix. At this point, toasted almonds are added and the whole mass is manually homogenized. The product obtained up to here is called Alicante *turrón* (Figure 3); however the process can be continued. After cooling the solid mass is crushed in a stone miller, at this time almond oil is released and the solid particles remain suspended in a continuous fat phase. The suspension is then heated with gentle stirring in a special hemispherical boiler-pan of

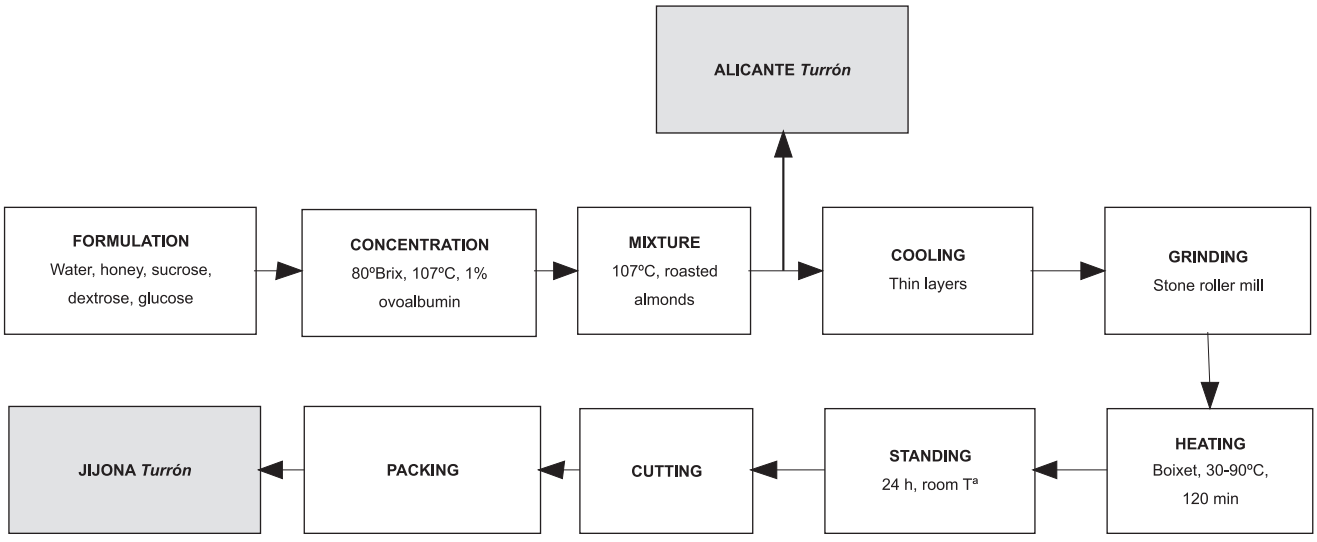


FIGURE 2. Flow diagram of Alicante and Jijona *turrón* manufacture processes.

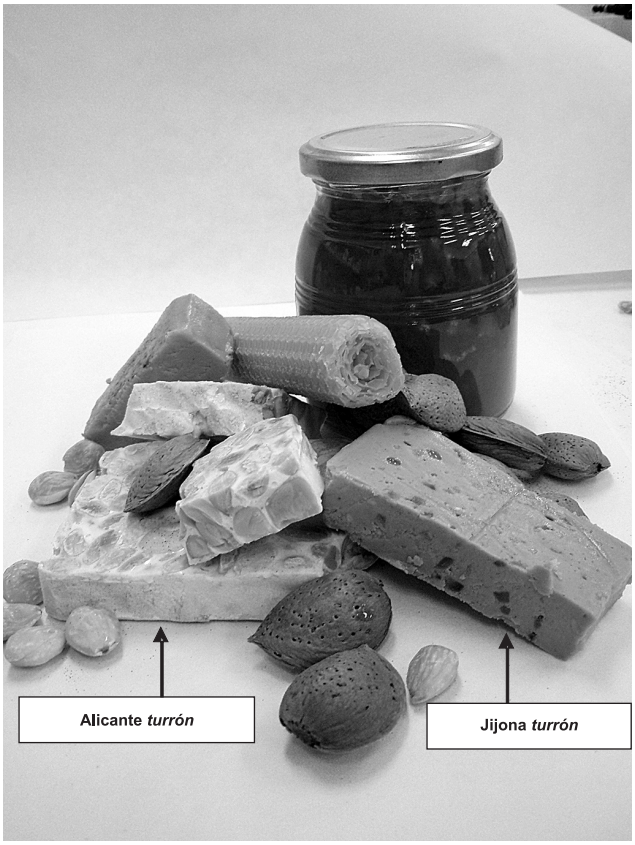


FIGURE 3. Alicante and Jijona *turrón* samples and their main ingredients, almonds and honey.

approximately 0.6 m diameter, called *boixet*, to 50-60°C and held at this temperature for about 1 h. It is then heated again to 70-80°C and held until the consistency seems to be right. The total holding time in the *boixet* is approximately of 120 min [Chiralt *et al.*, 1991; Lluch *et al.*, 1992]. The mass coming from the *boixet* is a deformable semi-solid soft mass. At room temperature, the product becomes harder, as a breakable non-flowing semi-solid called Jijona *turrón* (Figure 3).

In 1991, the Regulating Council of the Specific Denominations of Jijona and Alicante *Turrón* (RCSDJAT) was established and in 1996 the definitive backing of Europe was obtained with the qualifying Protected Geographical Indications (PGI), ratifying the denomination of Spanish origin. Since its creation, it has guaranteed the processing, analysis and registration of protected brands and of the raw materials used in the companies, via suitable systems of verification and inspection.

Article 11 of the Regulations of the Jijona and *Turrón* de Alicante Specific Denominations, approved by the Spanish Ministry of Agriculture, Fisheries and Food in 1996 established with great precision what should be the percentages of raw materials used in the making of protected *turrón* and requirements of fabrication:

*„Pure bees' honey, at least 10%. Clean, sound almonds with no foreign material and of the varieties Valenciana, Marcona, Mollar and Planeta. The minimum percentage of almond in the protected turrones will be 52% for Jijona and 46% for Turrón de Alicante. Without prejudice to the requirements set out by current legislation, turrones protected by specific denominations „Jijona" and „Turrón de Alicante" will correspond to the minimum quantities in production, qualities in raw materials and percentages required by this Regulation. The turrones must have the organoleptic qualities characteristic of the same in smell, aroma and taste. Turrones which in judgment of the Regulating Council do not have those characteristics will not be protected by the specific denominations „Jijona" and „Turrón de Alicante", and will be disqualified".*

Sensory analysis can satisfactorily contribute to research and to a better understanding of consumer acceptability. Although a PGI should protect the essence of its uniqueness, it should not ignore market trends, and should be able to adapt itself to the preferences of the consumer (presentation, sensory attributes, packaging, *etc*.).

Sensory attributes of foodstuffs are of great importance for preference and in PGI products they become essential. PGI products, apart from the characteristics of quality that every food manufacturer should comply with in modern distribution (consistency of quality, efficient commercial organization, *etc.*), must also rely upon their peculiarities and at the same time be capable of adjusting themselves to the preferences of market. This is the only reason to justify the higher price of most PGI products, and arises as a consequence of the traditional methods of production employed and due to a number of other types of limitations.

Another issue of importance is the contribution of sensory evaluation to the design of quality systems. Sensory evaluation can be considered as a technical support for quality assurance during production. To build upon this objective, for use with PGI products, it is needed to increase knowledge about both the raw material and technological causes for particular sensory attributes in order to be able to establish systems which can assure sufficient regularity of the quality characteristics for the product [Verdú *et al.*, 2007a,b; Vázquez-Araújo *et al.*, 2007; Vázquez *et al.*, 2007].

As far as *turrón* is concerned, there is a tremendous need for common sensory methods which can define *turrón* types (Jijona and Alicante) and qualities (Extra, Supreme and Improved Supreme) within an internationally understood framework. There are no testing methods reported in the scientific literature, concerning for example assessment panels, number of samples assessed, sample dimensions, presentation order, repetition, sensory vocabulary, method of profiling and scoring.

Over the last few years, research in the field of *turrón* science has made serious attempts to establish standardized evaluation methods in orders to specify and maintain the sensory quality of *turrónes*. In this way, the RCSDJAT has selected, trained and monitored a trained panel specialized in turrón and its main ingredients almonds and honey. This trained panel is available for all turrón companies for different purposes, for instance validating the changes they made in their production systems in order to modernized them and make them more energy efficient and more respectful with the environment.

In Spain, *turrón* is commercially classified according to its almond percentage. Table 1 contains the minimum requirements established by the Technical-Sanitary Regulation for the Production and Selling of *Turrón* and Marzipans [Mar-

TABLE 1. Minimum requirements in almond content in the different commercial categories of soft and hard *turrón* according to the Technical-Sanitary Regulation [BOE, 1996] and the RCSDJAT [RTS, 1982].

| *Turrón* Type | Category | Almond (%) [BOE, 1996] | Honey (%) [RTS, 1982] |
|---|---|---|---|
| Hard | Supreme | 60 | 10† |
| | Extra | 46 | -‡ |
| | Standard | 40 | -‡ |
| | Popular | 34 | -‡ |
| Soft | Supreme | 64 | 10¥ |
| | Extra | 50 | -‡ |
| | Standard | 44 | -‡ |
| | Popular | 30 | -‡ |

† Hard turrón with more than 60% almond and 10% honey can be called Alicante turrón if RCSDJAT conditions are satisfied. ‡ No extra, standard, or popular categories are supported by the RCSDJAT. ¥ Soft turrón with more than 64% almond and 10% honey can be called Jijona turrón if RCSDJAT conditions are satisfied.

tínez & Chiralt, 1995]. In this way, Supreme products (the only ones protected by specific denominations „*Jijona*" and „*Turrón de Alicante*") require minimum almond percentages of 60% in Alicante *turrón* and 64% in Jijona *turrón*. However, the RCSDJTA also establishes minimum requirements for honey content, as shown in Table 1 [Verdú *et al.*, 2007b].

It seems evident that just by using the content of almond and honey is an insufficient criterion for ensuring the quality of final *turrón* to consumers. In this way and following the example of IOOC and the virgin olive oil, the people responsible of the Quality and Certification Departments are developing a proper method for the commercial classification of the different *turrón* types supported by the RCSDJTA using both the contents of almonds and honey and their sensory quality.

The mastery of food products implies to integrate all the steps of their production and marketing, from the raw materials to the consumer. In this way, our team has applied sensory evaluation in several aspects:

***Turrón* concept.** The first aspect studied was that If *turrón* manufacturers want to widen their market, the first thing they need to know is which the consumers' concept of a high-quality *turrón* is and if this concept is the same for manufacturers. Jijona *turrón* was selected because it is the most traditional and popular type of *turrón* in Spain. The most important quality attributes of Jijona *turrón* were: hardness, oiliness, consistency, crumbliness, adhesiveness, almond content, honey aroma, almond aroma, and sweetness. Both consumers and manufacturers perceived these attributes in a similar way, indicating that consumers had a high knowledge of this product. However, while consumers want a product with high levels of sweetness and consistency and low levels of oiliness, manufacturers care more for intense honey and almond flavors.

**Toasting of almonds.** Three different almond cultivars (2 from Spain and 1 from USA) were compared for their differences in volatile compounds and sensory responses. A total of 58 compounds were detected in toasted almonds, including ketones, aldehydes, pyrazines, alcohols, aromatic hydrocarbons, furans, pyrroles, terpenes, and linear hydrocarbons. Pyrazines together with furans and pyrroles significantly contributed to the characteristic toasted aroma of almond. Further studies anre needed, however, to optimize the toasting conditions for each one fo the almond cultivars [Vázquez-Araújo *et al.*, 2007].

**Concentration of sugars and honey.** Traditionally, the manufacture of Alicante and Jijona *turrón* is a totally artisan process, with no control on most of the parameters involved in each of the unit operations. As a result of this lack of control, the product can be found on the market in a wide range of textures and flavors. To avoid this problem, detailed information on each one of the unit operations is needed. In this way, several authors [Martínez & Chiralt, 1995; Martínez *et al.*, 1996, 1997] have carried out detailed studies on the key step for the texture of Jijona *turrón*, the inversion phase operation „*boixet*". Vázquez *et al.* [2007] studied the initial concentration of sugars and honey, which will have an important effect on the final flavor of *turrón*. Sensory properties such as sweet taste and honey aroma and flavor will be significantly influenced by the experimental conditions of this step [Vázquez *et al.*, 2007]. During this step, characteristic honey volatile compounds decreased their concentration, for instance acetoin, benzaldehyde, phenylacetaldehyde, and linalool oxide, while compounds arising from amino acids and sugars through Maillard and Strecker degradation reactions significantly increased, for instance furfuryl alcohol, furfural and 5-methyl furfural.

## OTHER FOODS

### Chocolate

The chocolate industry is also very important in the province of Alicante with some of the most important Spanish companies located in Villajoyosa, for instance Chocolates Valor S.A. [hppt://www.valor.es]. This company uses two different types of sensory panels, the first one is dedicated to quality control and its main objective is to avoid that any defective product reaches the market and a second dedicated to product research and development. This is a three-generation family company and it is considered as a model company in its style. They have been using sensory evaluation for several decades but without a true scientific methodology; however, five years ago, they realize of the need of introducing sensory techniques in a proper manner and from thereafter, their panels are helping the success of this company.

### Ice-cream

Some important ice-cream companies are also located in the province of Alicante, for instance Jijonenca S.A. [hppt://www.jijonenca.es], which is located in Jijona. This a cooperative company owned by more than 400 different people; however, they have a modern vision of the market. People responsible of the Departments of Marketing, Quality Control and Research and Development are truly convince of the need of incorporating sensory techniques in their routine analyses and are introducing it since 2004.

**Dairy products**

Big companies, such as Puleva Biotech S.A. [http://www.pulevabiotech.es], use sensory evaluation in a daily basis in product development, quality control, and hedonic tests. The main advantages of these big companies is that they have trained personnel and infrastructure available for sensory tasks and what is even more important they are completely aware that sensory studies are essential for the improvement of the company.

Product development is an activity that ranges from new product development to several planned activities associated with changes to a product or a process. The new product cycle begins with a product idea generated from consumer research or technical discovery, and is complete when marketing research demonstrates sufficient consumer interest in this new product. Besides new product development sensory evaluation can also be used in product development activities such as pilot plant scale-up, cost reduction, ingredient/process change, and ingredients/purchase specifications.

Finally, what truly makes a difference in these big companies is that they have the economic resources to carry out hedonic tests in a whole country. Sensory evaluation supports marketing and marketing research activities beginning with new product development, and continuing through tracking product performance, and contributing to special assignments such as developing tests and data to support or challenge advertising claims. Puleva Biotech S.A. usually carries out this type of studies in the six most important cities in Spain: Madrid, Barcelona, Valencia, Bilbao, and Sevilla, and uses at least 500 interviews with regular or targeted consumers. The main reason for selecting five different cities is that market experts know that liking expectations within Spain are quite diverse. For instance, the weather is absolutely different in Bilbao (northern Spain): moderate coastal climate, Madrid (central Spain): continental climate, and Valencia (eastern Spain): Mediterranean climate.

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