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Relationship between sensory attributes and volatile compounds qualifying dry-cured hams

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Abstract

This work studies the relationship between 45 volatile compounds and 17 sensory attributes (13 flavour perceptions) of dry-cured hams. Volatile compounds were quantified by SPME-GC while the sensory assessment was carried out by 13 panellists. GC-sniffing was used to determine the odour impact zones of the chromatogram. The odour thresholds of the volatile compounds and their sensory characterisation were determined by dilution analysis. Six sensory attributes (acorn odour and flavour, rancid odour, rancid taste, fat rancid and fat pungent flavours) were explained by regression equations (adjusted $-R^2 \geqslant 0.70$) based on ten compounds: benzaldehyde, 2-heptanone, hexanal, hexanol, limonene, 3-methylbutanal, 3-methylbutanol, 2-nonanone, octanol, pentanol. Acorn flavour attribute was successfully emulated by mixing the volatile compounds selected by the equation. Its odour was evaluated by assessors that gave a sensory description that matches with the target. All the procedures performed for the elucidation of volatile-attribute relations showed a basic agreement in their results.

Keywords: Dry-cured hams; Flavour; Volatiles; Sensory assessment; Chemometrics

1. Introduction

Aroma sensory attributes are descriptions of a commodity from the sensory assessors' viewpoint. Thus, each foodstuff sensory panel produces its own list of attributes that is the result of a consensus between the food sensory perceptions and their intensities after extensive training and assessment work (Deibler & Delwiche, 2004; Piggot, 1988); a key aspect of any hypothetical consensus being to avoid sensory attributes that overlap (García-González et al., 2006). This redundancy cannot be easily resolved if the terms definition is not provided with a frame of reference but it becomes readily grasped by all the assessors when chemical compounds are provided. It explains why relating aroma sensory attributes and volatile compounds sometimes represents a challenge.

Furthermore, aroma perception is not induced by a simple stimulus but it is often a complex process in which each aroma is characterized by distinct compositions of a certain number of key volatiles (Aparicio, Morales, & Alonso, 1996). A good numerical relationship (e.g. $R^2 > 0.75$) between volatile compounds and sensory attributes does not automatically imply that the relative amount of a compound quantified in the food has a sensory impact on the food since only those compounds in concentrations higher than their odour threshold are odour-active (Buettner & Schieberle, 2000a; Carrapiso, Jurado, Timón, & García, 2002a; Grosh, 1994; Luna, Morales, & Aparicio-Ruiz, 2006b).

Little research has been dedicated to this field in fat products (Buscailhon et al., 1994; Carrapiso, Ventanas, & García, 2002b; Morales & Tsimidou, 2000), the statistical sensory wheel being the most available approach in the case of virgin olive oil (Aparicio-Ruiz et al., 1996). The sensory evaluation of dry cured ham, being a solid food, is even more difficult to deal with, since the strength of the aroma perception is affected by the release of volatile com-

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pounds during mastication. To explain the sensory attributes from the flavours release during eating it is necessary to assume that only those volatiles whose concentrations in the food material exceed their odour threshold can be selected (Buettner & Schieberle, 2000a) but keeping in mind that the perceived intensity of an individual volatile is almost always higher than the sum of the intensities of the volatiles that constitute the natural mixture that defines a particular odour (Laing, Panhuber, Willcox, & Pittman, 1984).

Several studies have been independently conducted on ham sensory attributes (Dirinck, Van Opstaele, & Vandendriessche, 1997; Pastorelli et al., 2003; Ruiz, García, Muriel, Andrés, & Ventanas, 2002) and on the volatiles of dry-cured hams (Andrés, Cava, & Ruiz, 2002; Luna, Aparicio-Ruiz, & García-González, 2006a; Ruiz, Ventanas, Cava, Andrés, & García, 1999; Sánchez-Peña, Luna, García-González, & Aparicio-Ruiz, 2005; Timón, Ventanas, Carrapiso, Jurado, & García, 2001). Authors agree that the aroma is perhaps the most important quality parameter of hams, and it is due to the presence of many volatile compounds, most of them produced by chemical and enzymatic mechanisms during the post-mortem process (Flores, Grimm, Toldrá, & Spanier, 1997); the main biochemical reactions being lipolysis and proteolysis (Toldrá, 1998). But the sensory quality depends not only of the curing process but also on factors such as the breed, age and feeding of pigs. Furthermore, ham samples are heterogeneous and, in consequence, the variability of the analytical results is related with the amounts of muscles and subcutaneous fat in every sample (García-González, Luna, Morales, & Aparicio-Ruiz, 2005; Luna et al., 2006a). It is well-established that chemical changes occurring in different muscles during the ripening of hams influence the ham aroma and flavour (Ruiz, Ventanas, Cava, Timón, & García, 1998). It is only recently that the contribution of the most important parts of the hams (subcutaneous fat, *biceps femoris*, *semimembranosus* and *semitendinosus* muscles) to their aroma and flavour has begun to be elucidated (Luna et al., 2006a; Monin et al., 1997; Sánchez-Peña et al., 2005).

The aim of this work is to determine the relationship between 13 odour and flavour sensory attributes and 45 volatile compounds in 41 hams from diverse geographical origins, maturation times, pig feeding, etc. Mathematical procedures have been used as a filter system to reduce the set of attributes and volatiles to those with high probabilities of being related. Odour threshold and GC-sniffing/olfactometry (henceforth, GC-O) complete the filtering process prior to formulating sensory attributes with volatile compounds.

2. Materials and methods

2.1. Samples

A total of 41 hams from several geographical parts of Spain and France were used for this study. These different samples somewhat reproduce the actual variability in dry-cured ham features that the consumer can find in the market, and allow enough scope to study the influence of different sensory traits on their acceptability.

Thirty were white hams from several crossbreeds – (French Landrace × Large White) × (Piétrain × Large White), (Duroc or Landrace) × (Landrace or Large white or Landrace × Large white) and Landrace × Large White crossbred sows mated with several genetic types – eight were Iberian hams – Iberian × Duroc-Jersey with a minimum of 50% Iberian pig-, and three were Gasconne and Basque hams although crossed with Large White and other genetic types.

The ripening time varied from one ham to another although they can be clustered into various groups, French hams were cured for less than 12 months with the exception of the hams from Bayonne. Spanish white hams were cured for a period between 10 and 18 months while Iberian hams were cured for more than 18 months. All the hams were processed by local manufacturers using the traditional method of each geographical origin (Flores & Toldrá, 1993; Sabio, Vidal-Aragón, Bernalte, & Gata, 1998). The samples were stored in vacuum plastic bags at –5 °C until they were required for the sensory and chemical studies.

2.2. Sensory analyses

Twenty-seven traits related to sensory characteristics of dry-cured hams (Table 1) were evaluated by the quantitative-descriptive analysis method (Stone, 1992). The traits were grouped into appearance (red colour, homogeneous red colour, subcutaneous fat, fat colour, heterogeneous fat colour, intramuscular fat), texture (crust, dry, melting, fibrous, elastic, sticky, doughty, fat greasy), odour (cured ham, rancid, acorn, mouldy, smoke), taste (salty, rancid) and flavour (raw meat, cured ham, acorn, fat rancid, fat pungent, pungent). Sensory attributes were assessed with a 9-points structured scale. The total number of assessors was 13, trained during 10 training sessions, although not all of them evaluated the whole set of samples. The minimum number of assessors per sample was ten.

All the samples, slices of 1.5mm thickness with 1 cm of subcutaneous fat, were evaluated at 20–22 °C in sensory panel rooms equipped with fluorescent lighting. About 50 ml of water and 20 g of unsalted bread were provided to assessors between successive ham samples. Samples were evaluated in eight sessions. The order of the sample presentation was randomised (García-González et al., 2006).

2.3. Reagents

Four chemical compounds (2-propanone, 2-ethyl furane, 2,3-butanodione and isobutyric acid) were identified by mass-spectrometry. All the other chemical compounds, described in Table 2, were purchased from Fluka–Sigma–Aldrich (St. Louis, MO). 4-methyl-2-pentanol was used as external standard.