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Salt and intramuscular fat modulate dynamic perception of flavour and texture in dry-cured hams

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ABSTRACT

The present study aimed to evaluate the influence of salt and intramuscular fat (IMF) content on the sensory characteristics of two different types of dry-cured hams (Iberian and Serrano) using the time–intensity (TI) method. All studied TI parameters of flavour attributes (overall flavour, saltiness, cured and rancid flavours) were significantly ($p < 0.05$) affected by variations in the salt and/or IMF content. However, regarding texture attributes only the maximum intensity (Imax) of hardness was significantly ($p < 0.05$) affected by the salt content of hams. Compared to Iberian dry-cured hams, the dynamic perception of the flavour and texture of Serrano dry-cured hams was less influenced by variations in salt and/or IMF content. The dynamic sensory techniques may be helpful to guarantee the quality of dry-cured products subjected to strategies of salt and fat reduction.

1. Introduction

Dry-cured ham industry has an important economic impact in Spain with a consumption of about 109.596 t in 2009 (MARM, 2010). Iberian and Serrano dry-cured hams differ in terms of chemical composition and sensory traits owing to the different genetic background of the animals (Iberian pigs vs. Industrial genotypes) (Ventanas et al., 2005). Iberian hams, in particular, are very appreciated by consumers due to their particular sensory properties partly attributed to the characteristics of the raw material (i.e. intramuscular fat (IMF) content and composition) and the length of the drying–ripening process (Ruiz, García, Muriel, Andrés & Ventanas, 2002). IMF of Iberian dry-cured hams contributes to flavour and odour perception through different mechanisms (lipid oxidation, Maillard reactions etc.) involved in volatile compounds formation (Ruiz et al., 2002). IMF also plays an important role in the perception of the texture of Iberian dry-cured hams, particularly in juiciness, since these products are strongly dehydrated and the contribution of moisture to the perception of this attribute is limited (Ventanas, Ventanas, Ruiz & Estévez, 2005). Fat stimulates the saliva secretion and contributes directly to juiciness by coating the tongue, teeth and other parts of the mouth acting as a lubricant agent (Lynch, Liu, Mela & MacFie, 1993).

The process of Iberian dry-cured hams includes a salting phase which is responsible for a variable concentration of sodium chloride in the final product (from 3.5% to 5.5% average) (Ventanas et al., 2005). Salt contributes to the flavour perception by likely increasing the volatility of aroma compounds thorough the salting out phenomenon (Rabe, Krings & Berger, 2003). Similarly to fat, salt also regulates the juiciness perception by stimulating salivation (Ventanas, Puolanne & Tuorila, 2010). Sensory attributes as hardness and pastiness are strongly dependent on salt since it modulates the degree of dry-cured ham drying and the activity of proteolytic enzymes (Toldrá, Flores & Sanz, 1997).

Nowadays, the population is aware that consumption of high levels of fat or salt enhances the risk of different diseases by increasing the cholesterol and blood pressure levels (USDA/HHS, 2010; WHO, 2012). Dietary fat intake should ideally account for between 15% and 30% of total diet energy (WHO, 2013) and meat products are identified as products for sodium reduction (EC, 2012). Taking into consideration the prominent role of IMF and salt on the sensory characteristics of Iberian dry-cured hams, it is known that salt and fat reduction certainly modifies texture and flavour perception (Andrés, Cava, Ventanas, Thovar & Ruiz, 2004; Fuentes, Ventanas, Morcuende & Ventanas, 2013).

Flavour and texture perception are dynamic phenomena which changes along the process of food consumption (Dijksterhuis & Piggott, 2001). Hence, the use of dynamic sensory techniques as Time–intensity (TI) is gaining importance in meat products and particularly in dry-cured ones (Emrick, Penfield, Bacon, Van Laack & Breeke, 2005; Fuentes, Estévez, Grèbol, Ventanas & Ventanas, 2014; Fuentes, Ventanas, Ventanas & Estévez, 2014; Fuentes et al., 2013; Reinbach, Toft & Møller, 2009; Ventanas, Puolanne & Tuorila, 2010). In the present study, pieces of Iberian and Serrano dry-cured hams varying in both IMF and salt content were selected to study the effect of both parameters on the dynamic perception of flavour and texture attributes.

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2. Material and methods

2.1. Selection of Iberian dry-cured hams

One hundred and twenty Iberian dry-cured hams with a wide range of fat and salt content were purchased from a local company ("Dehesa Serrana" S.A., Cáceres, Spain). Salt and fat content of these products were estimated at the Institute of Food and Agricultural Research and Technology (IRTA, Girona, Spain) using a non-destructive methodology called Computed Tomography technique (HiSpeed scanner model Zx/i, GE Healthcare, Barcelona, Spain). The thickness of subcutaneous fat which is a parameter related to the overall fat content of dry-cured hams was used as a reference for determining the fat content. The salt content was determined in muscles *Biceps femoris* (BF) and *Semimembranosus* (SM) using previously developed prediction models (Santos-Garcés et al., 2010) and other analytical tools which were developed using the Matlab mathematical software (Santos-Garcés et al., 2012). Finally, 20 of those Iberian dry-cured hams were selected for the study. Samples of 450 g were obtained from each ham (Fig. 1), packaged under vacuum and stored in refrigeration conditions for 5 months until reception in our laboratory.

2.2. Elaboration of Serrano dry-cured hams

Sixty green hams were obtained from different commercial slaughterhouses supplied by animals with different breeds containing a wide range of fat content. 42 hams from animals with crosses of *Large white* and *Landrace* breeds and 18 hams from animals with crosses with a minimum of 50% of *Duroc* breed were obtained. Homogeneous sets of hams in terms of weight and pH were used for the elaboration procedure. Fatness of hams was determined using Ham grading system (JMP Ingenieros, S.L., Sotés, La Rioja, Spain). Hams were salted individually with excess of salt during 0.6, 0.7, 0.8, 1.1, 1.2, 1.3, 1.4 and 1.5 days/kg of raw ham in order to get the variation of salt content present in the market. Each one of the salting times had hams with different fatness. After salting, hams were washed with cold water, weighed and hanged in a cold room at 3 °C to rest. The relative humidity inside the cold room was 75–80%, and the temperature was progressively increased (from 10 to 20 °C) until the end of the process. The process finished when a total weight loss of 36% was achieved. Finally, 28 of these Serrano dry-cured hams with a wide variation in fat and salt content were selected for the study. Sampling procedure was the same as previously reported for Iberian dry-cured hams (Fig. 1). Processing of Serrano dry-cured hams took place at the Institute of Food and Agricultural Research and Technology (IRTA, Girona, Spain).

2.3. Physico-chemical analysis

Each sample was analysed for chemical composition in triplicate. Moisture content was determined by drying the sample at 102 °C for 24 h (AOAC, 2000). Total protein content was analysed using the Kjeldahl method (AOAC, 2000). Fat content was determined according to the method developed by Folch, Lees, & Stanley (1957) and chloride content was analysed using the Volhard method (AOAC, 2000). Fatty acid methyl esters (FAMEs) were prepared by acidic-trans-esterification in the presence of sulphuric acid (5% sulphuric acid in methanol) (Ventanas, Ventanas, Tovar, García & Estévez, 2007). FAMEs were analysed by gas chromatography using a Hewlett-Packard HP-5890A gas chromatograph, equipped with an on-column injector and a flame ionization detector (FID), using a polyethylene glycol capillary column (Supelcowax-10, Supelco, Bellefonte, PA). Individual FAMEs were identified by comparing their retention times with those of standards of all fatty acids analysed supplied by Sigma Aldrich (Steintein, Germany). Results are expressed as percentage of the total fatty acids analysed.

2.4. Sensory evaluation

2.4.1. Assessors

Eleven panellists (six males and five females, range age: 26–54 years) with previous experience in TI evaluation participated in the study (training and evaluation sessions). All of them were staff at the University of Extremadura.

2.4.2. Panel performance

In order to ensure satisfying performance of the panel it is of great importance to study unwanted variation between the assessors. Graphically based methods can provide a way to quickly and effectively visualize panel performance in a simple and comprehensive manner (Tomic O., Nilsen A., Martens M. & Næs T., 2007). Free open source sensory software package called PanelCheck (Panel, 2006) was used to check whether the panel was well trained enough. The panel consisted of 11 assessors rating with time–intensity method the maximum intensity (Imax) of 6 attributes (attribute A: juiciness, attribute B: hardness, attribute C: fibrousness, attribute D: overall flavour, attribute E: saltiness and attribute F: cured flavour) on a scale from 1 to 10. A set of 4 dry-cured hams samples, 2 Iberian and 2 Serrano, were tested with two replicates per sample.

Fig. 2 shows the 3-way ANOVA plot for the assessor effect (2a), product effect (2b), replicate effect (2c) and the interaction between assessor and product effect (2d). Fig. 2a shows that the assessor effect was significant for juiciness, fibrousness, overall flavour and cured flavour.

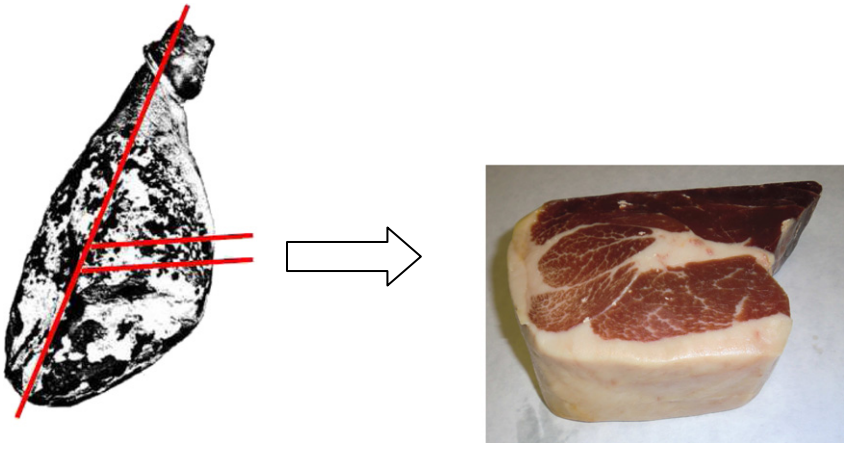

Fig. 1. Sampling of dry-cured ham.