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Effect of ripening time and rearing system on amino acid-related flavour compounds of Iberian ham

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Abstract

The evolution of free amino acids and amino acid-derived volatile compounds during the ripening of Iberian ham from pigs reared in a Montanera system (outdoor-based, with acorn and pasture available) and a Pienso system (indoor-based, with a high oleic acid concentrate) was studied. Ripening time influenced significantly all the free amino acids detected ($p < 0.05$) except for threonine and tyrosine. The total free amino acid content increased significantly from day 120 to day 230 (drying stage) and then the concentration remained almost steady. This marked increase in the free amino acid content matched an increase in the amino acid-derived volatile compounds. The volatile compounds also increased after day 230. Conversely, rearing system had a weak effect on the free amino acid content and on the amino acid-derived volatile compounds. Only glutamic acid was significantly influenced ($p = 0.027$), and a slight effect on proline and aspartic acid was found ($p = 0.051$ and $p = 0.084$, respectively), concentrations being larger in Montanera hams than in Pienso ones. With regard to the amino acid derived volatile compounds, only a significant influence of rearing system on acetaldehyde and on the coelution of 2,6-dimethylpyrazine+dihidro-2(3H)furanone was found. The small differences caused by rearing system confirm the great importance of concentrate formulation.

Keywords: Iberian ham; Flavour; Ripening time; Rearing system; Free amino acids; Strecker and Maillard compounds

1. Introduction

Iberian ham, a traditional dry-cured meat from the south-west of Spain, is considered a high-quality product, with flavour as an outstanding quality parameter and major contributor to consumer acceptance.

The sensory impression of flavour is due to the simultaneous stimulation of human olfactory and taste systems and is triggered by odour-active volatiles, taste-active non-volatiles and the interaction of these compounds (Piggott & Schaschke, 2001; Soldo, Blank, & Hofmann, 2003). With regard to the interaction, it has been established that Maillard compounds can enhance the taste of some free amino acids (Ottinger, Soldo, & Hofmann, 2003; Soldo et al., 2003).

The flavour of high quality, fully matured hams is the result of enzymatic reactions (proteolysis and lipolysis) and chemical processes (lipid autooxidation, Strecker and Maillard reactions) taking place throughout ham ripening. Iberian ham flavour depends on processing conditions (Ruiz, Ventanas, Cava, Timón, & García, 1998b) and also on raw meat characteristics, which are affected for example by genetic factors (Muriel, Ruiz, Martín, Petrón, & Antequera, 2004b) and diet (Carrapiso, Bonilla, & García, 2003a; Cava, Ventanas, Ruiz, Andrés, & Antequera, 2000).

Proteolysis is one of the most important biochemical processes occurring during the ripening of Iberian ham. It influences texture, but also flavour development due to the formation of free amino acids and other low-molecular

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weight compounds. Free amino acids take part directly in taste (Kato, Ra Rhue, & Nishimura, 1989), and also participate indirectly in flavour development because they are precursors of many odorants (Hidalgo & Zamora, 2004; Pripis-Nicolau, De Revel, Bertrand, & Maujean, 2000) important for meat products. Volatiles coming from amino acids are considered to have a great importance for the flavour of Iberian ham (Carrapiso, Ventanas, & Garcıa, 2002b) and other dry cured hams (Blank et al., 2001; Flores, Grimm, Toldrá, & Spanier, 1997b). The main routes for generation of volatile compounds from amino acids in Iberian ham are Maillard and Strecker reactions (Ventanas et al., 1992), which yield heterocyclic compounds containing nitrogen (such as pyrazines), sulphur or oxygen (such as furanones) and aliphatic compounds such as methyl branched aldehydes and alcohols (Mottram, 1998).

Most studies have reported, from a quantitative point of view, that compounds arising from lipid oxidation are the most abundant in the profile of volatile compounds of Iberian ham. Though in smaller amounts than those from lipid oxidation, some compounds generated through reactions involving amino acids have been described as the most odour-active compounds of Iberian ham (Carrapiso et al., 2002b) and they certainly contribute to the overall flavour of this product.

Currently, Iberian hams are classified into different commercial grades: ''Montanera hams'' are the most expensive and are obtained from pigs fattened outdoor on acorns and pasture; ''Pienso hams'' are the least expensive and are obtained from pigs fattened indoors on concentrate feed. Remarkable differences between the flavour characteristics of Montanera and Pienso hams have been reported, Pienso hams showing smaller scores for flavour (Carrapiso et al., 2003a; Cava et al., 2000; García et al., 1996) and a lower consumer acceptance and price than Montanera hams. In recent years, concentrates for Iberian pigs have experienced a marked change as result of the new trends towards simulating the feeding composition of Iberian pigs reared in Montanera, and in fact some of the concentrates have high oleic acid contents, even higher than the typical acorn and grass based diet of pigs reared in Montanera. Although the concentrate feeding composition is not considered to classify the hams, it has been found that the use of high oleic acid content concentrates improves the flavour characteristics of Iberian dry-cured loins from indoor-reared pigs (Muriel, Ruiz, Petrón, Andrés, & Antequera, 2003). However, no information about Iberian ham is available.

Although the water-soluble fraction of Iberian ham (and therefore the free amino acids) and the amino acids-derived volatile compounds are greatly involved in Iberian ham flavour, they have received less attention than lipids and lipid-derived volatile compounds. In addition, there is scarce information about how the formation of flavour compounds of Iberian ham takes place throughout ham ripening and about the influence of raw meat characteristics (such as rearing system of the pigs) on flavour compound development.

The objective of this study was to investigate the evolution of amino acid-related flavour compounds during ham ripening and the effect of rearing system on them when the feeding composition of indoor-reared pigs has been formulated to simulate the diet of pigs reared outdoors on acorn and grass.

2. Materials and methods

2.1. Raw Iberian hams

Eighty legs were obtained from Iberian pigs. Forty of them were obtained from Iberian pigs reared in cofinement on a high oleic acid concentrate (Pienso hams) (for details on composition, see Muriel, Ruiz, Ventanas, & Antequera, 2002). The others were obtained from Iberian pigs reared in a free-range system during the fattening period (75 days before slaughter), the only feed source being acorn and pasture (Montanera hams). All the animals were slaughtered at about 145 ± 10 kg (mean $\pm$ standard deviation).

2.2. Processing of the dry-cured Iberian hams

The hams were processed in controlled humidity and temperature rooms, first in a local factory (the first 100 days) and then in the Department of Food Science (University of Extremadura) by applying the usual temperature and relative humidity values of the traditional processing (conditions are detailed in Table 1). The whole process lasted 722 days. Actual conditions of temperature and relative humidity were registered and are shown in Fig. 1.

2.3. Sampling

Hams were sampled at five different times of processing: at the end of postsalting (day 120), at the end of the drying stage (day 230), and at the end of the first third (day 361), the second third (day 516) and the end of the cellar phase (day 722) (Fig. 1).

Five Montanera hams and five Pienso hams were sampled each time, except at the end of processing, when 20 Montanera hams and 20 Pienso hams were sampled.

Samples were obtained by extracting a cylinder (sized 10×2.5 cm) with a stainless steel tube with a cutting edge. The samples mainly included the Semimembranosus and Biceps femoris muscles. Samples were vacuum-packaged and kept frozen at -80 °C until being analysed. Subcutaneous and intermuscular fat were removed just before the analyses.

2.4. Chemical analyses

Moisture was determined according to the ISO-1442 method (ISO, 1997). NaCl was carried out following the Volhard method (AOAC, 1984).