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RESEARCH ARTICLE

Effect of the Inclusion of Chestnut in the Finishing Diet on Volatile Compounds of Dry-Cured Ham from Celta Pig Breed

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Abstract

The effect of the inclusion of chestnut in pigs finishing diet on volatile compounds of dry-cured Celta ham was studied. Twelve hams of each type (from three different pigs finishing diets: concentrate (CO), mixed (MI) and chestnut (CH)) were used. Volatiles were extracted using a purge-and-trap method and analyzed by gas chromatography/mass spectrometry (GC/MS). Thirty-nine volatile compounds were identified in dry-cured Celta ham samples. Most abundant volatiles in ham samples were aldehydes, which represented respectively, 53% (CO), 51% (MI) and 46% (CH) of the total volatile composition. With the exception of 2-butenal, 2-methyl, all aldehydes were affected by feeding system. On the other hand, hydrocarbons n-alkanes were the second major group in the volatile profile of dry-cured Celta hams and represented 28.9, 35.7 and 32.4% of the total volatile composition for CO, MI and CH groups, respectively. Ham samples from chestnut group showed a higher content of alcohols and this result could be related with the inclusion of chestnut in the finishing diet of pigs. Principal component analysis showed a good separation among groups. The discriminant analysis selected eight variables (butanoic acid, hexanal, octanal, nonenal (E), decenal (E), tetradecane, decane trimethyl and pyridine 2-methyl) and calculated two discriminating functions to predict if chestnut has been included in the finishing diet. Thus, it was possible to discriminate between groups fed with finishing diets containing chestnuts in their composition (mixed and chestnut group).

Key words: dry-cured ham, chestnut, volatile compound, finishing diet, discriminant analysis

INTRODUCTION

The Celta was the typical breed of pig raised on farms in Galicia (northwest Spain) until the middle of the 20th century, at that time, its rearing suffered an important recession due to the introduction of improved breeds and their crosses. Nowadays, Celta pig is the unique Galician autochthonous pig breed included in the Official Catalogue of Cattle Breeds of Spain as being in danger of extinction (R.D. 2128/2008). This breed is highly appreciated by consumers because of the succulent meat that results from the profuse infiltration of fat into the lean meat. The traditional rearing system of the Celta pig used to be closer to an extensive or semi-free range system than to an intensive system, but nowadays, it is commonly farmed intensively.

Celta ham is a typical meat product from the northwest of Spain, very appreciated by consumers. This high consumer acceptability is mainly sustained on its unique sensory features, which are consequence of both the characteristics of the raw material and the prolonged traditional processing method that requires

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between 1 and 2 years ripening.

Chestnut (*Castanea sativa* Mill.) has been awarded as Geographically Protected Identity (G.P.I.) (Official Journal of the European Communities 2010) being the NW of Spain the main production area. At the present time, the chestnuts are underutilized and this situation contrasts with the high current prices of commercial concentrates for animal feed.

In dry-cured products, chemical and biochemical changes during ripening lead to a large number of volatile compounds which contribute to their characteristic flavour (Ruiz *et al*. 2002). Proteolysis and lipolysis are two of the most important mechanisms that have an impact on final sensory quality. Proteolytic events have been shown to be an important source of aroma and flavour, as they release several compounds related to flavour development, such as free amino acids (Naes *et al.* 1995; Ordóñez *et al.* 1999). Lipolysis also plays an important role in the development of sensory characteristics, because it causes an increase in free fatty acid content, and it also catalyses other reactions such as oxidation, which leads to the production of a large number of volatile compounds that are responsible for the characteristic flavour of certain food (Yang *et al.* 2005).

So, the aim of this study was to evaluate the effect of the inclusion of chestnut in the finishing diet on volatile compounds of dry-cured ham from Celta pig breed. Moreover some of these volatile compounds could be used as discriminating factors for the finishing diet system.

RESULTS AND DISCUSSION

The fatty acid profiles of intramuscular fat (IMF) of the hams studied in the present work have been previously reported (Bermudez *et al.* 2012). In this work, an oleic enrichment of IMF of the hams due to inclusion of chestnut in the diet was observed (39.9, 44.9 and 44.5% for concentrate (CO), mixed (MI) and chestnut (CH) groups, respectively). Moreover, as a consequence of concentrate feeding, an increase in linoleic acid (13.6, 10.9 and 11.5% for CO, MI and CH groups, respectively) and in SFA proportion (40.3, 35.5 and 35.6% for CO, MI and CH groups, respectively) with a parallel decrease in the monounsaturated fatty acid (MUFA) percentage (43.8, 50.7 and 49.8% for CO, MI and CH groups, respectively) was observed. Polyunsaturated fatty acid (PUFA) percentage was 15.8, 13.7 and 14.6 for CO, MI and CH groups, respectively.

A total of 39 volatile compounds were identified in Celta hams from the three different feeding diets: CO, MI and CH. These volatile aroma compounds could be classified into several chemical groups: acids (1), alcohols (4), aldehydes (13), furans (3), hydrocarbons: n-alkanes (6), hydrocarbons: branched alkanes (4), aromatic hydrocarbons (2), ketones (3), nitrogen compounds (1), sulphur compounds (1) and chloride compounds (1).

Most abundant volatiles in ham samples were aldehydes (see Table 1), which, from a biochemical point of view, are products originated in lipid oxidation or amino acid degradation. They represent respectively, 54% (CO), 51% (MI) and 46% (CH) of the total volatile composition. With the exception of 2-butenal, 2-methyl, all aldehydes were affected by feeding system. It is noteworthy, the no presence of four aldehydes (octanal, 2,4-hepatadienal, 2-nonenal and 3-decenal) in chestnut group.

Chestnut inclusion in the diet affected the detected amounts of aldheydes. The levels of heptanal of CO group as well as the levels of octanal, nonanal, 2-nonenal and 2-decenal were significant ($P<0.01$) higher as a result of concentrate feeding. Heptanal and nonenal might mainly result from the oxidation of n-9 MUFA, such as oleic acid (Ladikos and Lougovois 1990). This decrease in the content of oleic acid with commercial fodder was not in agreement with the parallel higher amount of heptanal detected in samples. Similar results were reported in dry-cured loin (Martin *et al.* 2009). An additional source of these volatiles compounds different to the oxidation of oleic should not be discarded and the involvement of the oxidation of linoleic acid in the formation of heptanal might be possible. In fact, according to Grosh (1987), despite heptanal is formed mainly by oxidation of n-9 MUFA, it could also be formed by n-6 PUFA oxidation. Concerning to the increase of 2-nonenal in CO group, the formation of this compound has been related to the oxidation of linoleic acid (Shahidi 1994), so the higher the level of linoleic acid in IMF of hams the higher