VOLATILE COMPOUNDS IN DRY-CURED HAM PRODUCED FROM HEAVY AND LIGHT *LARGE WHITE* PIGS

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SUMMARY

Aroma of dry-cured ham is related with the composition of volatile compounds produced as result of the hydrolytic and oxidative reactions during the process of elaboration. The improvement of sensorial quality can be achieved by different ways; the use of heavy pigs allows the application of longer processes that can facilitate the production of high quality hams. Two batches of 20 castrated male pigs (*Large white*) were produced and sacrificed at two weights: 90 and 130 Kg. Hams were elaborated by the same process: salting step at 3°C (day/Kg ham weight), post-salting at 3-5°C during 64 days and drying: 10-12°C to 20°C (75 days), 20-26°C(111days) and 14-16°C(90 days). Cured ham were taken at the end of process for analysis. Volatile profile was obtained via a dynamic head-space gas chromatography-mass spectrometry system. Heavy hams showed a higher concentration of aldehydes and cetones.

Introduction

Dry-cured ham is an important meat product in Spain with a production that arises 20×10^6 units a year. Sensorial quality is influenced by raw material and biochemical changes taking place during the processing. Volatile profile have been described in dry-cured ham produced with different process: country-style hams (Ockerman et al. 1964; Lillard and Ayres 1969); Italian and Parma hams (Giolitti et al. 1971), Iberian hams (Antequera 1991; García et al. 1991; Antequera et al. 1992; López et al. 1992) and French hams (Berdague et al. 1991, 1993). Carbonyl compounds are the most abundant volatiles and they can be produced by lipid oxidation during dry-cured ham process. Fat composition is related with the susceptibility to oxidation and the production of volatile compounds (Frankel, 1982). On the other hand intramuscular fat can affect the salt distribution and the oxidative reactions on ham muscles. Traditionally heavy pigs were used to produce cured hams; since, Iberian pigs are sacrificed at weights around 140 Kg; these pigs have a high level of intramuscular fat and a high percentage of oleic acid; the hams produced from this kind of pigs are the most appreciated by consumers. So, there is the possibility that heavy pigs from white pigs could be more appropriate to obtain dry-cured ham with better sensorial characteristics. In this work a comparison of volatile profile of heavy and light hams have carried out to establish the influence of weight.

Material and Methods

Two batches of 20 castrated male pigs (*Large white*) were produced with the following conditions: animal nutrition was the same for the two batches: animals were kept in individual pens, with free access to pelleted diet consisting (Kg-1) of 725.6 g barley, 20 g animal and vegetable fat, 157.2 g soya beans, 9.7 calcium carbonate, 14.4 g dicalcium phosphate, 2 g salt, 2.1 g DL-methionine, 4 g mineral and vitamin meat. The energy of the diet was 3100 Kcal (13 MJ) metabolisable per Kg air-dry weight feed. Both groups of animals were sacrificed at the same time. Fresh hams were taken for dry-cured ham production.

Dry-cured ham production

Light and heavy hams were produced with the following steps: Hams were covered with salt at 3°C during 15 days, after hams were placed in a drying room with the following conditions: post-salting 64 days at 3-5°C and drying: 12-14°C (75 days), 16-22°C (111 days) and 22-14°C (90 days).

Samples
Samples were taken at the end of the process. *Semimembranosus* and *Biceps femoris* muscles were removed and homogenized. A aliquot was taken for analysis.

Volatile collection and GC-MS conditions
25 g of sample were placed into a glass vessel connected to a stream of helium, at 50 ml/min and 70°C during 20 minutes. The volatiles were absorbed on graphited carbon trap (length 10 cm). The trap was removed and introduced in an automatic dynamic head space system (Retorik, Switzerland). The compounds were desorbed by heating the trap at 600°C (microwave energy) during 4 seconds, then injected into a Carlo Erba (Mega 5360) gas chromatograph coupled to a mass spectrometer (Fissons TRIO 2000). A FSOT capillary column 5% phenylmethylsilicone (DB-5, J&W) 40 m x 180 µm and a film thickness of 0.4 µm was used; temperature program of 50 °C (initial) and 5°C/min to 300°C. Injection mode used was split at a ratio 1:20. Scans were adquired in the following conditions: scan range 35-400 u.a.m. (1scan/sec) in the mode electron impact (70 eV), multiplier voltage 350 V, interface temperature 300°C. The identification was carried out by using the comparison with mass spectra of Wiley library, Kovats index, mass spectra of known compounds and external standards. To obtain relative concentrations (*d*6) deuterated toluene was used as internal standard by applying 1 µg to muscle sample before volatile collection. The effect of weight was assessed by variance analysis and t-test.

Results and Discussion

The most significative results were a higher concentrations in heavy hams of aldehydes and cetones. Hexanal, heptanal, octanal, nonanal, 2,3-butanedione and heptanone presented higher concentrations in both muscle in heavy hams than light ones (Fig. 1). Aldehydes and cetones were the class compounds with the higher concentrations, and hexanal showed high concentrations in *Semimembranosus* muscle. Relative concentrations of alcohols were low; 1-octen-3-ol was the most abundant. Hexane was the main hydrocarbon detected, in this case light hams had higher concentrations than heavy hams; aliphatic and aromatic hydrocarbons were identified. Dimethyldisulphide, phenyloxirane and dimethylpirazine were detected but significative differences were not found between heavy and light hams. These results agree with the previous reported by Berdague et al. (1991, 1993) and Garcia et al. (1991) and Antequera et al. (1992). However, in a study in French hams cetones were the main compounds described Berdague et al. (1994). Lipid oxidation seems to be the main process to produce volatile compounds, but the importance of this process or other cannot considered only in quantitative basis, because compounds with low concentrations could be most important from the point of view of sensorial properties. Aminoacid degradation can contribute via the formation of dimethyldisulphide and dimethyltrisulphide that were identified in both kind of hams and muscles; it should be pointed out that olfactory threshold of dimethyldisulphide is below 12 ng/g; in a parallel study over the same batches of hams a unstability of sulfur containing aminoacids was observed (Hortós, 1994). The presence of methylbutanal is an index of valine, leucine and isoleucine degradation; the lack of significative differences for methylbutanal could be related with the absence of significative differences in the releasing of aminoacids (Hortós, 1994). In this work 2-penthylfurane was detected, this compound has been described previously by Berdague et al. (1993), but in Iberian hams it was not reported, showing a possible effect of raw material and/or curing process on volatile composition.

Conclusion
Heavy hams showed higher concentrations of aldehydes than light hams, this result joint with the higher hexane concentration in light hams is related with a different oxidation pathway. Further studies are necessaries to establish if this behaviour is similar in other breeds and the relation with sensorial quality of ham produced from heavy pigs.

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References
Antequera, T. (1990). Evolución del componente lipídico durante la maduración del jamón de cerdo ibérico. Tesis Doctoral. Facultad de Veterinaria. Universidad de Extremadura.

Antequera, T., López-Bote, C., Córdoba, J. J., García, C., Asensio, M.A., Ventanas, J., García Regueiro, J.A. and Díaz, I. (1992). Lipid oxidative changes in the processing of iberian pigs hams. Food Chem., 45:105.

Berdagué, J.L. and García, C. (1990). Volatile compounds of dry-cured ham. VPC., 11:319-320

Berdagué, J.L, Bonnaud, N., Rousset, S. and Touraille, C. (1991). Volatile compounds of dry-cured ham: identification and characterization by sniffing. Proc. 37th ICoMST, Kulmbach, 1135-1138

Berdagué, J.L., Bonnaud, N., Rousset, S. and Touraille, C. (1993). Incidence of pig crossbreed on the composition, volatile compound content and flavour of dry-cure ham. Meat Sci., 34: 119-129.

Frankel, E.N. (1982). Volatile lipid oxidation products. Prog. Lipid Res., 22:1

García, C., Berdagué, J.L., Antequera, T., López-Bote, C., Córdoba, J.J., Ventanas, J. (1991). Volatile components of dry-cured Iberian hams. Food Chem., 41:22-32

Giolitti, G., Cantoni, C., Bianchi, M. A., Renon, P., Beretta, G. (1971). Microbiologia and cambiamenti biochimici nei prosciutti crudi durante la stagionatura. Arch. Vet. Ital., 22:61-86

Hortós, M. (1994). Tesis doctoral. Facultat de Ciències. Universitat Autònoma Barcelona.

Lillard, D. A. and Ayre, J.C. (1969). Flavour compounds in country cured hams. Food Technol., 23:117-120

Ockerman, H.W., Blumer, T.N., Craig, H.B. (1964). Volatile chemical compounds in dry cured hams. J. Food Sci., 29:123-129

López, M.O., De la Hoz, L., Cambero, M.I., Gallardo, E., Reglero, G. and Ordoñez, J.A. (1992). Volatile compounds of dry-cured hams from iberian pigs. Meat Sci., 31:267-277

Fig. 1. Relative concentrations of selected compounds in light and heavy hams. BF, *Biceps femoris*. SM, *Semimembranosus*.