Journal of Food Composition and Analysis 52 (2016) 33–43

Contents lists available at ScienceDirect

Journal of Food Composition and Analysis

journal homepage: www.elsevier.com/locate/jfca

Original research article

Lipid characteristics of dry-cured "Tocino" during the manufacturing process. Effects of salting intensity and ripening temperature

Francisco J. Méndez-Cid, Inmaculada Franco, Sidonia Martínez, Javier Carballo*

Área de Tecnología de los Alimentos, Facultad de Ciencias, Universidad de Vigo, Campus As Lagoas s/n, 32004 Ourense, Spain

ARTICLE INFO

Article history:
Received 22 December 2015
Received in revised form 17 June 2016
Accepted 25 July 2016
Available online 28 July 2016

Keywords:
Colour parameters
Dry-cured Tocino
Fat healthiness
Fat oxidation
Fatty acid profile
Food analysis
Food composition
Lipolysis
Salting intensity
Ripening temperature

ABSTRACT

The fatty acid composition, the lipid characteristics and the colour parameters of Tocino, a salted and ripened meat product made from subcutaneous backfat from pig, were studied throughout manufacturing of the product. The effects of the ripening temperature and of the duration of the salting process were also studied. Ripening process caused a significant ($P<0.001$) decrease in the total and some individual polyunsaturated fatty acids (C18:2n-6, C18:3n-3, C20:2n-6, C20:3n-6, C20:4n-6, and C20:3n-3), particularly in the polar lipid fraction (total polyunsaturated fatty acids descended from 13.6 to 3.5% of total methyl esters). Increased ripening temperature (from 8 to 12 °C) and longer duration of salting (from 2 to 4 days) caused a significantly greater decrease in the content of polyunsaturated fatty acids. The nutritional and health index values indicated that Tocino is not a healthy product. During the ripening stage, Tocino underwent moderate lipolysis and very intense lipid oxidation (final values of 3.57–5.09 mg KOH/g of fat and 0.84–1.16 mg malondialdehyde/kg). Increasing the ripening temperature significantly increased ($P<0.001$) both lipolysis and fat oxidation, while increasing the duration of salting only had a significant positive effect on oxidation processes. Longer ripening times led to a significant increase ($P<0.001$) in the b* values (from 8.81 to 18.7–23.7) and significant decreases in the a* (from 7.10 to −3.31 – −4.04) and L* (from 81.5 to 66.4–70.2) values.

1. Introduction

Subcutaneous fat is an important part of some dry-cured products such as dry-cured ham and bacon, and it is also used as an ingredient in other products such as pâté and sausages. Some traditional products also valorize the subcutaneous fat of pig. Dry-cured "Tocino" is a meat product made from the dorsolateral subcutaneous fat and is commonly consumed in the Iberian peninsula. The raw pieces used for its manufacture consist of subcutaneous fat, with or without skin, cut from the dorsal line and comprising the costal and ventral areas (Spanish Royal Decree no. 474, 2014). The pieces are first dry-salted and then dried and ripened for a variable period of time. The final product is consumed both raw and cooked in traditional dishes.

The quality of dry-cured Tocino depends on the composition and properties of raw fat and on the changes undergone during the manufacturing process. Due to the nature of this product, changes in the lipid fraction are responsible for the sensory characteristics of the final product. Lipolysis and oxidation are the main degradation processes that affect lipids during the processing of dry-cured pork products (Gandemer, 2002). Lipolysis plays an important role in the development of sensorial characteristics in processed meat products because of an increase in free fatty acid and diacylglycerol contents and a decrease in triacylglycerol content (Coutron-Gambotti and Gandemer, 1999; Motilva and Toldrá, 1993). These reactions are influenced by several factors such as the length of the different stages of the manufacturing processes, the level and the method of salting, and the ambient conditions during ripening (Buscailhon and Monin, 1994; Toldrá and Flores, 1998). This process occurs faster during the first months of processing and then slows down (Narváez-Rivas et al., 2007).

The oxidative changes that occur in lipids are complex processes that cause important modifications in meat and fat during processing and storage of meat products (Morrissey et al., 1998). During lipid oxidation, unsaturated fatty acids react with molecular oxygen, giving rise to primary and secondary products, most of which have an important effect on the overall flavour of dry cured meat products because of their typical aromas and their low

* Corresponding author.
E-mail address: carbatec@uvigo.es (J. Carballo).

http://dx.doi.org/10.1016/j.jfca.2016.07.005
0889-1575/

odour threshold (Dirinck et al., 1997). These reactions occur during the processing and continue during storage (Motilva and Toldrá, 1993). Many factors are involved in lipid oxidation, including composition and characteristics of the fresh meat or fat (Ruiz and López-Bote, 2002) and the processing conditions (Buscailhon et al., 1993; Toldrá et al., 1997). During ripening, high temperatures, long drying times and high salt contents enhance lipid oxidation (Coutron-Gambotti and Gandemer, 1999; Toldrá and Flores, 1998). Besides its specific action, salt contains impurities such as metallic ions that favour its pro-oxidant effect (Ladikos and Lougovois, 1990).

The high presence of fat in the human diet in developed countries and the demonstrated effects of the fatty acid composition of the diet on cardiovascular disease and several other chronic diseases (WHO, 2003) have led to an increased interest in knowledge about the composition of fatty foods.

Despite the widespread acceptance and consumption of dry-cured Tocino, no scientific studies have been conducted on this meat product, and processing is still carried out using traditional procedures. Information on similar products (cured lard) is available (Paleari et al., 2004; Sirtori et al., 2005; Serra et al., 2007), but the studies are limited (only the main fatty acids were quantified in the total fat) and do not consider the effects of the manufacturing and ripening conditions. Consumers are increasingly demanding products of high quality, and it is therefore necessary to establish the scientific basis of the manufacture of products of high and constant quality. The aim of the present study was to characterize the lipid fractions and to study the lipolytic and oxidative changes that take place during the manufacture of dry-cured Tocino as well as the effect on these processes of some important processing parameters such as salting intensity and ripening temperature.

2. Materials and methods

2.1. Samples and experimental design

Raw pieces of Tocino backfat were obtained from pigs of the pure Celta breed (an autochthonous breed in NW Spain) crossed with Duroc (C × D). Thirty pigs, castrated males and females, were used. The pigs were reared and fattened in an extensive outdoor system in a natural environment with huts, bushes and enough trees to provide shade. They were fed "ad libitum" with commercial feed (17% protein, 2.4% fat and 3250 kcal/kg metabolic energy) and had free access to water. Live weight at slaughtering was 165 ± 7.5 kg. The pigs were stunned using carbon dioxide and exanguinated, scalded, skinned, eviscerated and chilled according to standard commercial procedures. The carcasses were jointed in the pilot plant of the Meat Technology Centre of Galicia (San Cibrao das Viñas, Ourense, Spain) 24 h after slaughter. Backfat pieces (two from each carcass) were cut from the dorsal line to the middle of the thoracic area and from the 6th to the 12th thoracic vertebrae.

Four batches of dry-cured Tocino were manufactured, each comprising five backfat pieces. Fresh backfat pieces weighing around 2 kg each, including the skin, were first salted with coarse salt in piles comprising alternate layers of backfat pieces and salt. Two batches were salted for 2 days (1 day/kg) and the other two batches for 4 days (2 days/kg); the temperature of the salting room varied between 2 and 5 °C and the relative humidity between 80 and 90%. Once the salting finished, the pieces of fat were removed from the pile, brushed and washed. The pieces from two batches (one salted for 2 days and one salted for 4 days) were transferred to a ripening room for 9 months at 8 °C and around 75% relative humidity. The pieces from the two remaining batches were transferred to another ripening room where they were dried and ripened for 9 months at 12 °C and around 75% relative humidity.

Samples were taken from each batch, when fresh and after 1, 3, 6, and 9 months of drying-ripening. Each sample consisted of an entire piece of backfat.

The described experiment was carried out in triplicate.

Samples were transported to the laboratory under refrigeration (<4 °C). Once in the laboratory, the colour parameters were determined and each piece was skinned and minced for further analysis. Minced samples were stored at −80 °C for no longer than 3 months until analysis.

2.2. Determination of the proximate composition

Moisture and fat were quantified according to the ISO recommended standards 1442:1997 (ISO, 1997) and 1443:1973 (ISO, 1973), respectively. Total chlorides were quantified according to the Charpentier-Volhard official method (ISO 1841-1:1996) (ISO, 1996).

2.3. Determination of fatty acid content of the different fractions

Fat extraction was performed according to Folch et al. (1957). The lipid fractions (neutral lipids, phospholipids and free fatty acids) were separated for further analysis in NH_2-aminopropyl minicolumns, according to the method described by Kaluzny et al. (1985). The procedure described by Shehata et al. (1970), with some modifications, was used for lipid methylation. Identification and quantification of the fatty acid methyl esters from the different fractions were performed by gas chromatography in a Trace GC (Thermo Finnigan, Austin, TX) chromatograph equipped with a split/splitless AI 3000 autoinjector and a flame ionisation detector. Samples were injected in split mode. Separation of the different fatty acids was carried out on an Innowax column: length 30 m, ID 25 mm, film thickness 0.25 μm (Agilent Technologies, Palo Alto, CA). The temperature of the detector was 250 °C and that of the injector 230 °C. The gases used were hydrogen (35 mL/min), air (335 mL/min) and helium (carrier gas) (30 mL/min). The following chromatographic conditions were used for fatty acid determination: 50 °C for 1 min; ramp 1: 5 °C/min to 248 °C; ramp 2: 248 °C for 6 min.

For identification and quantification of the fatty acid methyl esters, a standard (Sigma Chemical Co., St. Louis, MO) containing the methyl esters of the following fatty acids was used: butyric (C4:0); caproic (C6:0); caprylic (C8:0); capric (C10:0); undecanoic (C11:0); lauric (C12:0); tridecanoic (C13:0); myristic (C14:0); myristoleic (C14:1); pentadecanoic (C15:0); *cis*-10-pentadecenoic (C15:1); palmitic (C16:0); palmitoleic (C16:1); margaric (C17:0); *cis*-10-heptadecenoic (C17:1); stearic (C18:0); oleic (C18:1 cis); elaidic (C18:1 trans); linoleic (C18:2); linolelaidic (C18:2 trans); linolenic (C18:3); arachidic (C20:0); *cis*-11-eicosenoic (C20:1); *cis*-11, 14 eicosadienoic (C20:2); *cis*-11, 14, 17-eicosatrienoic (C20:3); arachidonic (C20:4); heneicosanoic (C21:0); behenic (C22:0); erucic (C22:1); *cis*-13, 16 docosadienoic (C22:2); *cis*-4, 7, 10, 13, 16, 19-docosahexaenoic (C22:6); tricosanoic (C23:0); lignoceric (C24:0); and nervonic (C24:1). The standard contained between 2 and 4% of each of these fatty acids. The individual fatty acids were identified according to their retention times with reference to standards. For quantification of the free fatty acids with external standards, calibration curves were prepared using different concentrations of each methyl ester. Fatty acids of total lipids, glycerides and phospholipids were expressed as the percentage area of total identified fatty acid methyl esters, while free fatty acids were expressed as mg/100 g of fat.

All samples and standards were injected at least in duplicate. Repeatability tests were carried out by consecutive injection of a standard and a sample six times in a day. Reproducibility tests were also performed by injection of standard and sample twice a day for