Meat Science 98 (2014) 622–628

Contents lists available at ScienceDirect

Meat Science

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

A model explaining and predicting lamb flavour from the aroma-active chemical compounds released upon grilling light lamb loins

Mónica Bueno [a], M. Mar Campo [b], Juan Cacho [a], Vicente Ferreira [a], Ana Escudero [a,*]

[a] Laboratory for Aroma Analysis and Enology, Aragón Institute of Engineering Research (I3A), Department of Analytical Chemistry, Faculty of Sciences, University of Zaragoza, 50009 Zaragoza, Spain
[b] Department of Animal Production and Food Science, University of Zaragoza, 50013 Zaragoza, Spain

ARTICLE INFO

Article history:
Received 20 February 2014
Received in revised form 22 May 2014
Accepted 17 June 2014
Available online 26 June 2014

Keywords:
Lamb flavour
Model
Odour activity values
Carbonyl compounds
Odour-active compounds

ABSTRACT

The objective of the work is to understand the role of the different aroma compounds in the perception of the local "lamb flavour" concept. For this, a set of 70 loins (*Longissimus dorsi*) from approximately seventy day-old Rasa Aragonesa male lambs were grilled and the aroma-active chemicals released during the grilling process were trapped and analyzed. Carbonyl compounds were derivatizated and determined by GC-NCI-MS, whereas other aromatic compounds were directly analyzed by GC-GC-MS. Odour activity values (OAVs) were calculated using their odour threshold values in air. Lamb flavour could be satisfactory explained by a partial least-squares model (74% explained variance in cross-validation) built by the OAVs of 32 aroma-active chemical compounds. The model demonstrates that the lamb flavour concept is the result of a complex balance. Its intensity critically and positively depends to the levels of volatile fatty acids and several dimethylpyrazines while is negatively influenced by the different alkenals and alkadienals. (E,E)-2,4-decadienal and (E)-2-nonenal showed top OAVs.

1. Introduction

Consumers consider flavour one of the main sensory properties decisive in their selection, acceptance and ingestion of a particular food (Fisher & Scott, 1997). The overall flavour experience perceived during consumption of food is elicited by a combination of nasal and oral stimulation (Noble, 1996). One of the most important intrinsic elements is aroma, being the main determinant of meat flavour (Mottram, 1998). Furthermore, meat flavour is one of the most important sensory attributes which can be used to identify animal species (Matsuishi, Igeta, Takeda, & Okitani, 2004). The concept of lamb flavour quality varies from one region to another (Font i Furnols et al., 2009, 2011). Nevertheless, a number of studies have attempted to decode the different factors influencing lamb flavour: variations in diet, age, gender, castration, slaughter weight and freezing (Bailey, Suzuki, Fernando, Swartz, & Purchas, 1994; Jeremiah, Tong, & Gibson, 1998; Lind, Berg, Eilertsen, Hersleth, & Eik, 2011; Muela, Sañudo, Campo, Medel, & Beltrán, 2012; Resconi et al., 2010; Sutherland & Ames, 1995).

Statistical tools such as principal component analysis (PCA) or partial least square regression (PLSR) are widely used to develop models and to study relationships either between different factors and the quantitative data or either other factors and sensory perception in lamb meat (Bueno et al., 2011; Elmore et al., 2005; Muela et al., 2012). But, the relationship between the analytical data of specific aroma-active compounds and sensory data is not commonly studied together in lamb (Bueno et al., 2013; Resconi et al., 2010; Zhan, Tian, Zhang, & Wang, 2013). This suggests the need to open a new field of study: learning about the role of the different components in the formation of the aromatic concept and especially the interaction of families of compounds with lamb flavour.

Therefore the main objective of this study was to understand the role played by the different aroma compounds released during grilling on the lamb flavour concept. For such a goal, all the relevant odourants found in previous gas chromatographic-olfactometric (GC-O) studies were detected, quantified and ranked by their potential aromatic importance via the use of the Odour Activity Value concept (Grosch, 2001). Afterwards, partial least square regression models have been built to elucidate the role played by the different compounds.

2. Material and methods

2.1. Samples, freezing and frozen storage

This study used 70 Rasa Aragonesa male lambs (approximately seventy days-old) with a mean cold carcass weight of 11.5 ± 0.1 kg, which had been exposed to different freezing methods and frozen storage durations (Bueno et al., 2013) to provoke diverse flavour intensities. The animals were fed in the same facilities under intensive husbandry conditions (Pastores Grupo Cooperativo). They were suckling during the first 40 days from the mother with no grazing. Afterwards, they had concentrate ad libitum, composed mainly of barley and maize, until slaughtering in a EU-licensed abattoir following standard protocols. The slaughter protocol was described by Muela, Sañudo, Campo,

* Corresponding author. Tel.: +34 976 762503; fax: +34 976 761292.
E-mail address: escudero@unizar.es (A. Escudero).

http://dx.doi.org/10.1016/j.meatsci.2014.06.019
0309-1740/

Medel, and Beltrán (2010). As can be seen in Fig. 1, at 4 days post-slaughter, the left side of 60 carcasses, minus the neck, shoulder, flank and leg, were divided into two parts (one from the 5th thoracic to the 13th thoracic, T5–T13, and the other from the 1st lumbar to the 6th lumbar vertebrae, L1–L6). Carcasses were randomly exposed to different freezing methods (nitrogen freezing tunnel, air blast freezer and home freezer) and frozen storage duration (1 or 10 months). To prevent freezer burn and water losses, each part of the carcass (T5–T13, L1–L6) was over-wrapped in a retractile oxygen-permeable plastic film (permeability 10 g m^{-2} water, 200 cc m^{-2}/24 h O_2, and 650 cc m^{-2}/24 h CO_2) matching similar conservation procedures at home. Before conducting the instrumental measurements and the sensorial analysis of the meat, the samples were thawed in a refrigerator (2–4 °C) for 24 h inside their plastic over-wrap. All treatments (3 freezing methods × 2 frozen storage duration) were thawed at the same time. After thawing, the *Longissimus thoracis* and *lumborum* muscles were excised with the subcutaneous fat, vacuum packed in oxygen impermeable barrier bag and kept at 2–4 °C 24 h before analysis. T5–T13 samples were used for the carbonyl compound quantification and L1–L6 samples were used for the sensorial analysis, and other volatile quantification. The remaining 10 carcasses were not frozen. These animals were subjected to the same slaughter, chilling, splitting and wrapping procedures as described above, not frozen, rather held in a refrigerator (0–4 °C) for 6 days. This time was equivalent to the total time of the ageing of the thawed meat (96 h previous to freezing + 24 h during thawing + 24 h after excision).

2.2. Reagents, standards and materials

2.2.1. Solvents

Dichloromethane, methanol, hexane and diethyl ether (gas chromatography quality) were purchased from Merck (Darmstadt, Germany). Ethanol was supplied by Panreac (Barcelona, Spain). Water was purified in a Milli-Q system from Millipore (Bedford, Germany).

2.2.2. SPE cartridge materials

LiChrolut EN® resins (styrene/divinylbenzene copolymer) and 1 mL internal volume polypropylene cartridges were supplied by Merck. Glass wool was purchased from Panreac. Semiautomated solid phase extraction was carried out with a VAC ELUT 20 station system from Varian (Walnut Creek, CA, USA).

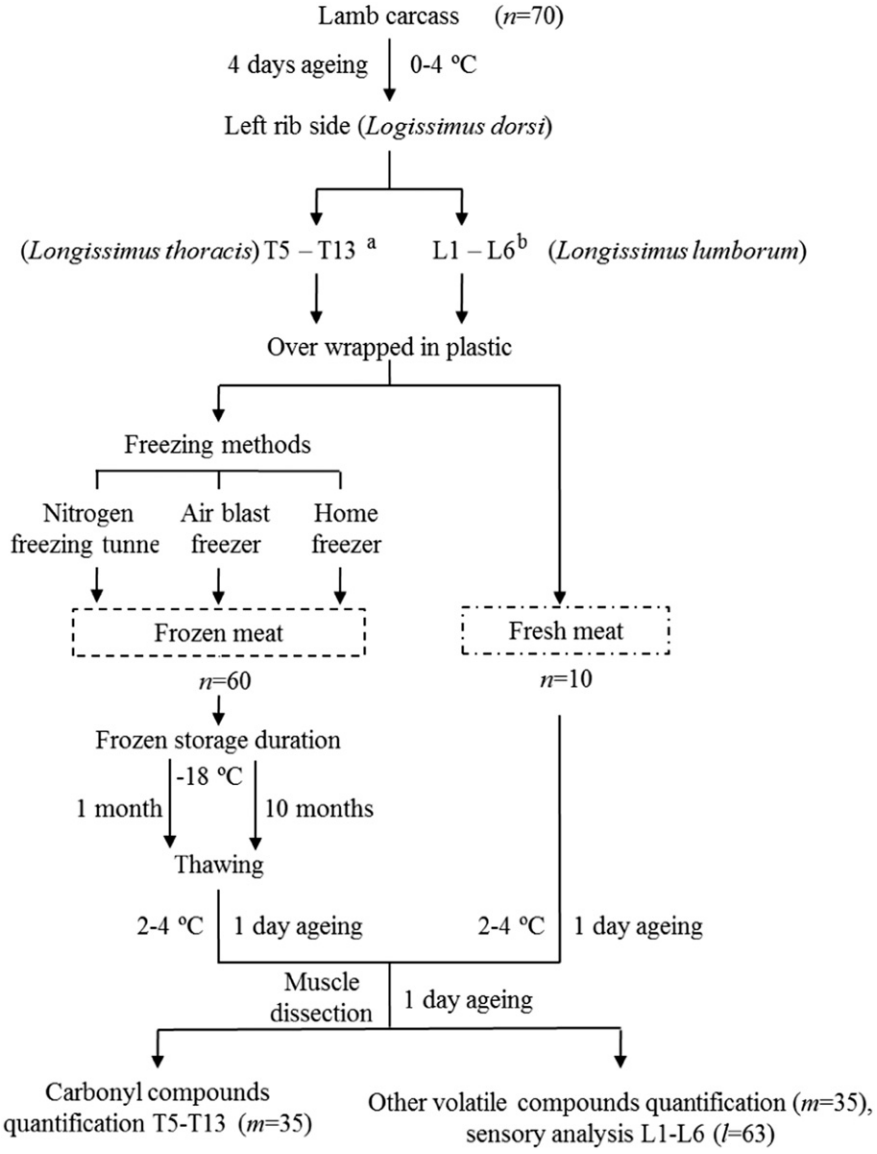

Fig. 1. Sampling protocol. a: from the 5th thoracic to the 13th thoracic vertebrae, b: from the 1st lumbar to the 6th lumbar vertebrae, *n*: number of animals, *m*: number of extracts obtained from 70 loins (each extract was obtained from the fumes of two loins during grilling), *l*: number of loins tasted by the sensory panel.