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Muscle lipid composition in bulls from 15 European breeds

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ABSTRACT

Cattle meat provides essential nutrients necessary for a balanced diet and health preservation. Besides nutritional quality, consumers' preferences are related to specific attributes such as tenderness, taste and flavour. The present study characterizes the fatty acid composition of beef, which is an important factor in both nutritional and quality values, in 15 European cattle breeds fed a similar diet and reared in five countries (United Kingdom, Denmark, France, Italy and Spain). The effect of possible slight differences on diet composition which might have occurred between countries were included in the breed effect which confounds country, diet, slaughter house and slaughter day as all individuals of a same breed were managed simultaneously. The wide range of breeds studied and the significant differences on lipid profile described here provide a broad characterization of beef meat, which allows giving a better response to the variety of consumers' preferences. Regarding meat health benefits, the groups that stand out are: the double-muscled animals, which displayed lower total fat, lower proportion of saturated (SFA) and monounsaturated (MUFA) fatty acids, and a higher proportion of polyunsaturated (PUFA) fatty acids; and Limousin and Charolais breeds with a significantly higher conversion of 18:3n-3 PUFA to the long chain 22:6n-3 PUFA.

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1. Introduction

In the last years, a number of epidemiological studies have associated red and processed meat consumption with the development of vascular diseases and colon cancer (Cross et al., 2007; Kontogianni et al., 2008; World Cancer Research Fund/American Institute for Cancer Research, 2007), despite the fact that over many years of evolution, human kind has become adapted to consume large amounts of lean red meat (Mann, 2000). However, associations between red meat consumption and increased disease risks are still unclear given that in many studies it is impossible to isolate the effects of red meat alone (see McAfee et al. (2010) for revision) and other authors have failed to find these negative effects of unprocessed red meat consumption (Alexander et al., 2009; Hodgson et al., 2006; Hodgson et al., 2007; Micha et al., 2010). Instead, several studies point out the possible health benefits in relation to unprocessed red meat intake (McAfee et al., 2010), although isolation of the effects of red meat alone is difficult to accomplish. Its moderate consumption was found to lower total cholesterol, LDL cholesterol and triglycerides (TG) (lean beef diet vs. poultry vs. lean fish diet, Beauchesne-Rondeau et al., 2003), as well as blood pressure (~215 g/d lean meat diet vs. control, Hodgson et al., 2006). Moreover, red meat contributes key nutrients to the diet, notably conjugated linoleic acid (CLA), haem iron, B vitamins, zinc, selenium and retinol, and also can have an important role as a dietary source of n-3 fatty acids (n-3 FAs) (Davey et al., 2003; Givens and Gibbs, 2008; Givens, 2010; McAfee et al., 2010). Therefore, it is unlikely that reducing red meat consumption alone would be sufficient to diminish health risks (McAfee et al., 2010).

Apart from health issues, the fatty acid (FA) composition also influences the technological and sensory quality of meat (Wood et al., 2004) and depends on several factors, mainly on breed effect and systemic location of individual depots in ruminants (Webb et al., 1998; Zembayashi et al., 1995).

The aim of this study is to determine the variation in lipid profile and sensory parameters of *Longissimus thoracis* muscle within and among 15 European cattle breeds, reared under comparable management conditions, and to represent the diversity in fatty acid content among the 15 cattle populations.

2. Material and methods

2.1. Animals and feed system

A total of 436 unrelated pure bred bulls belonging to 15 European breeds were used (EC QLK5 – CT2000-0147). The breeds included beef breeds, either local or worldwide used, and dairy breeds. The whole sample included 31 Jersey, 27 South Devon, 30 Aberdeen Angus, and 29 Highland from United Kingdom; 29 Holstein, 29 Danish Red, and 20 Simmental, from Denmark; 30 Asturiana de los Valles, 31 Asturiana de la Montaña, 30 Avileña-Negra Ibérica, and 31 Pirenaica from Spain; 30 Piedmontese, and 28 Marchigiana from Italy; and 31 Limousin, and 30 Charolais from France.

Bulls were reared in each country in a unique location and under a uniform beef management system representative of those used in the European Union (EU) countries. Animals were reared under intensive conditions with *ad libitum* access to concentrate. Feed composition and management details are described in Albertí et al. (2008). Briefly, animals were fed a total mixed ration containing barley and soy bean with appropriate minerals and vitamins. All ingredients were mixed into a form that prevented selection using molasses up to 3–5% as a binding agent. Metabolizable energy of the ration was 12.5-kJ/kg and straw was available *ad libitum* to provide fibre. Bi-carbonate was added to the ration to prevent acidosis. This diet was designed to achieve the slaughter weight of 75% of mature weight for each breed within a window of 13–17 months. Animals from each breed were slaughtered the same day in either commercial or experimental abattoirs, depending on the experimental facilities of each country. All animals were fasted before slaughter for less than 24 h and had free access to water. Stunning of animals was performed using captive bolt pistol and no electrical stimulation of carcasses was performed.

2.2. Sampling and determination of total lipid content

Carcass processing after slaughter was described by Albertí et al. (2008) and Christensen et al. (2011). For lipid measurements, *Longissimus thoracis* muscle was excised at 24 h postmortem from the left side of the carcass between the 6th and the 13th rib and a sample was taken immediately and frozen for chemical analysis including lipid profile. The remainder was stored at $+2 \pm 1$ °C until 48 h postmortem. Also, samples were taken from the 48 h postmortem section to determine total lipid content. Samples for individual FA analysis were taken from the same position on *Longissimus thoracis* from all animals. Samples were vacuum packed, frozen and transported on dry ice to University of Bristol (United Kingdom) to determine total lipid content.

2.3. Phenotypes measured

Fatness score corresponding to the visual fatness cover was estimated by UE standard (R.(CEE) n° 1208/81, 2930/81, 1026/91 and 1026/91) classification, with a 15-point scale (1, very low fat to 15, very high fat). Fat percentage was also measured as the proportion of subcutaneous and intermuscular fat in the rib dissection (Piedrafita et al., 2003). Fat was extracted by the method of Folch et al. (1957), separated into neutral lipid (NL) and phospholipid (PL), methylated, separated by gas–liquid chromatography (GLC) and the individual peaks of each FA were identified and quantified as described in detail by Scollan et al. (2001). Total lipid content was taken as the sum of the NL and PL fractions. Some additional phenotypes were set as are saturated FA (SFA), monounsaturated FA (MUFA), polyunsaturated FA (PUFA), n-3 PUFA, n-6 PUFA, n-6/n-3 ratio, 18:2/18:3 ratio, P:S1 [(18:2n-6+18:3n-3) / (12:0+14:0+16:0+18:0)] and P:S2 [(18:2n-6+18:3n-3+20:3n-6+20:4n-6+20:5n-3+22:4n-6+22:5n-3+22:6n-3)/(12:0+14:0+16:0+18:0)] ratios, and the antithrombotic potential (ATT), which is the ratio between the sum of the