BREED AND FEEDING EFFECT ON FATTY ACID COMPOSITION OF INTRAMUSCULAR FAT IN YEARLING BULLS

Aldai, N.[1], Murray, B.E.[2], Troy, D.J.[2], Oliván, M.[1], Martínez, A.[1], Nájera, A.I.[3], Osoro, K.[1]
[1]Servicio Regional de Investigación y Desarrollo Agroalimentario (S.E.R.I.D.A.). Apdo. 13 - 33300 Villaviciosa, Asturias, Spain
[2]Teagasc, The National Food Centre, Dunsinea, Ashtown, Dublin 15, Ireland
[3]Área de Tecnología de los Alimentos. Facultad de Farmacia. Universidad del País Vasco/Euskal-Herriko Unibertsitatea. Paseo de la Universidad 7, 01006 Vitoria-Gasteiz, Spain

Background

Pasture diets have sustained lower live weight gains relative to those achieved with high-concentrate diets, and the cattle finished at pasture have produced carcasses with a low fat content (Steen & Kilpatrick, 1998). But pasture-finished cattle may produce beef with a more desirable fatty acid (FA) composition in terms of its beneficial effect on human health (Kinsella, 1988), especially in relation to the content of *n-3* polyunsaturated fatty acids (PUFA) (French et al., 2000; Steen *et al*., 2003; Varela *et al*., 2004). On the other hand, breed can also affect muscle fat quality, where FA variations are mostly related to intramuscular fat levels and consequently to neutral and polar lipids ratios (Scollan *et al*., 2001).

Objectives

The purpose of the present work was to study the effect of breed and feeding system on intramuscular fat and total fatty acid contents of *Longissimus thoracis* muscle in beef cattle.

Materials and methods

Animal management

Eight yearling bulls from "Asturiana de los Valles" (AV) (beef breed adapted to extensive production systems) and eight yearling bulls from "Asturiana de la Montaña" (AM) (small to medium-sized hardy animals, adapted to mountain systems) were studied. Four AV and 4 AM animals were reared under extensive conditions on ryegrass and clover pastures and received a finishing diet during the last 60 days composed of concentrate meal (84% barley meal, 10% soya meal, 3% fat, 3% minerals, vitamins and oligoelements) and barley straw *ad libitum*. The other eight animals (4 AV and 4 AM) were managed under intensive system (concentrate meal, same composition) and barley straw *ad libitum* in the housing facilities of the Institute (S.E.R.I.D.A.). Animals were slaughtered with an average weight of 554 kg for intensively reared AV and 504 kg for extensively reared AV animals, and 463 kg for intensively reared AM and 461 kg for extensively reared AM animals. Slaughtering was performed in a commercial abattoir according to a routine procedure, and after dressing the carcasses were chilled at 3ºC for 24h.

Measurements

Twenty four hours *post-slaughter* the left half carcass was quartered and the part of the rib joint comprised between the 6th and 9th ribs extracted and transported to the laboratory. The 6th rib was excised and *Longissimus thoracis* (LT) muscle was separated, aged at 4ºC for 7 days and then minced with an electrical chopper, vacuum packed and kept at –20ºC until determination of intramuscular fat content by near infrared spectroscopy (Oliván *et al*., 2002). The LT of the 8th rib was extracted, vacuum packed and frozen at –80ºC for subsequent FA composition analysis by gas chromatography (GC).

Total fatty acid analysis

The FAs were extracted in 5M KOH in methanol/water (50:50) at 60ºC for 1 hour and esterified at 40ºC during 10 min with 2M trimethylsilyl-diazomethane in *n*-hexane according to Elmore *et al*. (1999) with some modifications. Separation of fatty acid methyl esters (FAMEs) was performed on a Varian CX3400 GC with a flame ionisation detector (FID) and a split/splitless injection port (50:1). GC analysis was performed using a B-PX 70 for FAME column (120m x 0.25mm i.d., 0.2µm film thickness) with programmed oven

temperature. Injector and detector ports were set at 270°C and 300°C, respectively. The carrier gas was hydrogen and the flow rate 1.6 ml/min measured at the initial temperature. Esterified FAs were identified according to similar peak retention times using standards and quantified according to internal standard method ($C_{23:0}$ methyl ester) added prior to saponification.

Statistical analysis

The statistical analysis was conducted using the SPSS11.5 program (2002). Principal component analysis was applied to explain, with a limited number of factors, the variation produced by breed type and feeding system on intramuscular fat level and on total fatty acid composition.

Results and discussion

The biplot (Figure 1) represents the first two principal components, which explained 72.8% of the variation observed on intramuscular fat level and fatty acid composition (individuals, groups and ratios). The first principal component (PC1) explained 55.6% of the variation observed, whilst the second principal component (PC2) explained an additional 17.2%.

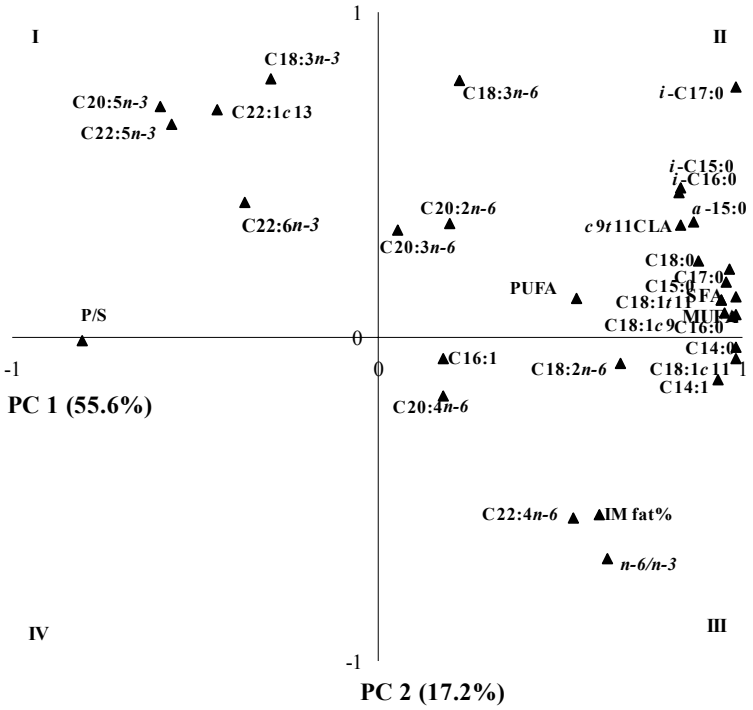

Figure 1. Biplot representation of principal components (PC1 & PC2) of different variables studied on the *Longissimus thoracis* muscle**.**

IM fat %: intramuscular fat percentage; *c*9,*t*11 CLA: *c*9,*t*11 C18:2; ∑SFA = C14:0 + C15:0 + C16:0 + C17:0 + C18:0; ∑MUFA = C14:1*c*9 + C16:1*c*9 + C17:1*c*10 + C18:1*t*11 + C18:1*c*9 + C18:1*c*11 + C22:1*c*13; ∑PUFA = C18:2*n-6* + C18:3*n-6* + C20:2*n-6* + C20:3*n-6* + C20:4*n-6* + C22:4*n-6* + C18:3*n-3* + C20:5*n-3* + C22:5*n-3* + C22:6*n-3* + *c*9*t*11 CLA*; n-6/n-3* = (C18:2*n-6* + C18:3*n-6* + C20:2*n-6* + C20:3*n-6* + C20:4*n-6* + C22:4*n-6*) / (C18:3*n-3* + C20:5*n-3* + C22:5*n-3* + C22:6*n-3*); P/S = ∑PUFA / ∑SFA.

The first principal component (PC1) was positively related to saturated, branched and monounsaturated FAs, and *c*9,*t*11 CLA contents. In consequence, it was also positively related to groups of aforementioned FAs (SFA & MUFA). In a lower degree, intramuscular fat level (IM fat %), PUFAs group and *n-6/n-3* ratio were also positively related to PC1. On the other hand, P/S ratio was negatively related to this principal component.

The second principal component (PC2), in general, was positively related to *n-3* FAs (in a low degree to $C_{22:6}$*n-3*) and *i*-$C_{17:0}$. However, it was negatively related to intramuscular fat level (IM fat %), *n-6/n-3* ratio and $C_{22:4}$*n-6*.

Figure 2 represents the projection of principal components (PC1 & PC2) for meat samples studied where meat samples were identified with feeding system and breed type labels. From these preliminary results it can be observed that feeding system was the most remarkable effect. In general, as there were some exceptions, extensively reared AV and AM breeds were separated from intensively reared AV and AM breeds. Both breeds (AV & AM) showed a similar behaviour from fat quantity and quality point of view when animals fed pasture. However, it is important to note that variability was higher in intensively fed animals in comparison to extensively fed ones. So taking into account the difficulty of the data interpretation, PC1 seemed to be negatively related to extensively reared animals and positively to intensively reared animals. And consequently, pasture fed animals could be related to *n-3* FAs and P/S ratio. This association between extensive system and *n-3* FAs was also seen by Steen et al. (2003) in pastured animals from crosses of the continental beef breeds and Varela et al. (2004) in extensively reared Rubia Gallega breed. On the other hand, animals fed with concentrate were related to PC1, and therefore, to SFAs, branched FAs, MUFAs, PUFAs (particularly *n-6* FAs), *c*9,*t*11 CLA, *n-6/n-3* and IM fat. Intensively fed animals of the rustic breed (AM), which basically laid in quadrant III, could be related to IM fat (%) and *n-6/n-3* ratio. In general feeding system effect seemed to be more clear in AM breed than in AV breed, as in the last one, when animals were fed with concentrate, high dispersion of the data was observed. On the other hand, the differentiation between both breeds was difficult on each feeding regime, and animals from both breeds appeared mixed in both feeding systems, concentrate and pasture.

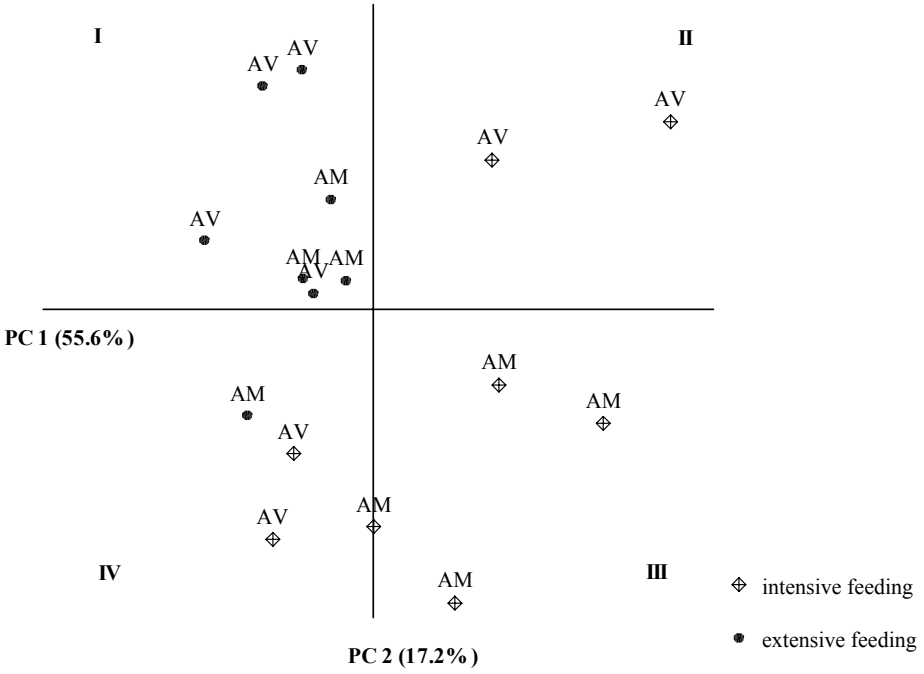

Figure 2. Projection of principal components (PC1 & PC2) of meat samples studied. AV: Asturiana de los Valles; AM: Asturiana de la Montaña.

Conclusions

These preliminary results from few animals are indicating that feeding system effect was more pronounced than breed type effect on intramuscular fat quality. Extensively produced meat showed a low fat content, high *n-3* PUFAs content and high P/S ratio, where pasture fed AV animals produced meat was the best adapted to human nutritional requirements. Breed effect was not significant in intensively, nor in extensively, reared animals.

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