Lipid Composition of Intramuscular Fat of Beef from Local Spanish Cattle Breeds Stored under Modified Atmosphere

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Background

As far as most consumers are concerned, meat should contain only a small amount of fat. Too much fat discourages the purchase of meat and is commly removed either before cooking or during the meal. But most of consumers want some fat, partly because the concept of the ideal cut of meat includes fat, and also because a small amount of fat is required for optimum eating quality. This is because fat confers the characteristic species flavour on meat through a complex interaction between components of fat and lean and also because it prevents drying out during cooking.

Breed affects the composition and quality of fat tissue mainly through its effect on total fat content (Leat, 1977). However, breed comparison of fatty acid composition are difficult because of the confounding of age, plane of nutrition and other extrinsic factors (Eichhorn *et al.*, 1986).

Ageing is another important factor that influences lipid composition, but little has been reported about the lipid composition of beef stored under an oxygen enriched atmosphere. The effect of new conservation techniques on lipid composition should be studied, because product safety and quality are both essential for consumer acceptance of meat products (Hoffmann, 1994; Ender, 1995). Therefore, the study of fat, product acceptability and modified atmosphere conservation techniques are neccesary.

Objectives

The purpose of the present work was to study the lipid composition (lipid fractions:C: cholesterol, FFA: free fatty acids, TG:PL: triglycerides:phospholipids ratio; and fatty acid composition: PUFA: polyunsaturated fatty acids, MUFA monounsaturated fatty acids, SFA: saturated fatty acids) of beef steaks from three local Spanish cattle breeds stored under an oxygen enriched atmosphere.

Methods

In the present work, 18 young bulls from 3 local Spanish native cattle breeds (6 animals/breed) were studied: Asturiana de los Valles, Parda Alpina and Pirenaica. Parda Alpina comes from Swiss but it was introduced in Spain at the end of the century, and together with Parda Alpina and Pirenaica they are reared in semiextensive livestock systems from the North of Spain. The three of them are beef cattle and selective breeding is being carried out on them to improve meat production. Animals were slaughtered at approximately 470 kg live weight. After 24 h *postmortem*, *longissimus dorsi* muscle was removed from the left carcass side and it was fabricated in 2-3 cm steaks. Samples were placed in plastic foam trays, packed in Polyamide/Polyethylene pouches and then flushed with 60% O_2, 30% CO_2 and 10% N_2 (Extendapack 52) with an EGARVAC machine (MAP). After packaging all samples were kept at 2±1°C in the dark and 90-95% relative humidity until days 0, 5, 10 and 15. After each of the storage periods, samples were vacuum packaged (99% of vaccum) and they were then stored at -20°C until lipid composition analysis.

Isolation of lipids: intramuscular fat was extracted by the Bligh and Dyer method (1959). Thin layer chromatography (Alzueta, 2000) was used to separate and then quantify lipid fractions (C, FFA, TG:PL) by densitometry. Total fatty acid composition was determined by gas chromatography (ISO, 1990). Other variables: the degradation of odour and colour assessed at the sensory evaluation and the TBA oxidation values of beef were previously reported (Insausti *et al.*, 2000). These variables were also included in the statsictical analysis with the aim of studying the possible relationship between these variables and the lipid composition of intramuscular fat. Statistical analysis was carried out with the SPSS 6.1.2 statistics programme (1995).

Results and discussion

The anlaysis of variance showed that there was no breed x days of storage interaction for the studied variables ($p>0.05$) (C, FFA, TG:PL, PUFA, MUFA, SFA). FFA increased from day 0 to day 5, as reported by Currie and Allen (1971), and then they decreased slightly until day 15 ($p<0.05$) (figure 1). TG:PL ratio decreased during storage ($p<0.05$) (figure 2). Beef from Asturiana de los Valles showed the lowest TG:PL ratio because it had the lowest TG content and the highest PL content ($p<0.05$). So, it was observed a breed effect on the PL content, as reported by Wood and Lister (1973). Figure 3 shows that C content remained quite constant during storage. Beef from Asturiana de los Valles showed the highest C values, while beef from Parda Alpina showed the lowest values during storage ($p<0.05$). This higher C content, together with the higher PL content, previously reported for meat from Asturiana de los Valles, would let us presume that this breed provides leaner muscles (Eichhorn, 1985) with lower adiposite size. Besides, high C contents are negatively related to the intramuscular fat content (Hood and Allen, 1971).

Regarding the fatty acid composition, beef from Asturiana de los Valles showed the lowest PUFA, MUFA and SFA content and Parda Alpina showed the highest values ($p<0.05$) (figure 4) because they had the lowest and the highest intramuscular fat percentage, respectively (Alberti,1993). PUFA, MUFA and SFA remained constant from day 0 to day 15 because aging time might have not been long enough to show differences among these sums of fatty acids, as it was also reported by Alzueta (1999) in Friesian and Pirenaica breeds.

Asturiana de los Valles pointed out at the factorial analysis and at the discriminant analysis because its lower fat content (PUFA, MUFA, SFA, TG) and at the discriminant analysis it also showed a higher C content (figure 5; 91.38% of the cases correctly classified). Concerning the effect of days of storage, function 1 at the discriminant analysis separated days 0 and 5 from days 10 and 15 because of the decrease in FFA with increasing storage days (figure 6; 65.52% of the cases correctly classified). These results were in agreement with those obtained at the analysis of variance.

The multiple regression analysis by the stepwise method related the degradation of aroma and colour assessed at the sensory

evaluation with the PL and FFA content, and beef oxidation, TBA value, with the PUFA, FFA and C content.

Predicted aroma= 21.233 + 39.87 (PL) -53.870 (FFA); R^2= 0.375

Predicted colour= 13.529 +44.217 (PL) -52.037 (FFA), R^2= 0.314

Predicted TBA= 2.618 - 0.007 (PUFA) -4.408 (FFA) + 3.423 (C), R^2= 0.334

These results are in agreement with those from MacLeod and Seyyedain-Ardebili (1981) who reported that FFA and PUFA, originated by the PL lipolysis, are involved in lipid oxidation and also in the resulting meat flavour. Besides, lipid oxidation was also related to pigment oxidation and thus to colour degradation (Faustman *et al.*, 1989).

Conclusions

The evolution of the studied variables under an oxygen enriched atmosphere was not very different from the evolution reported by Alzueta (1999) for these same variables in beef from Pirenaica and Freisian breed stored under vacuum. The main effect that pointed out in this work was breed, by means of the intramuscular fat content.

Finally, FFA, PL and PUFA content were related to beef quality (aroma, colour and lipid oxidation).

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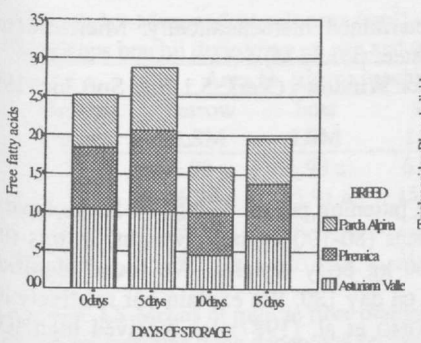

Fig. 1.- Free fatty acid content (O.D. x mm)

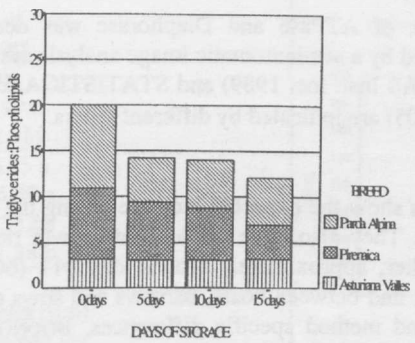

Fig. 2- Triglycerides:phospholipids content

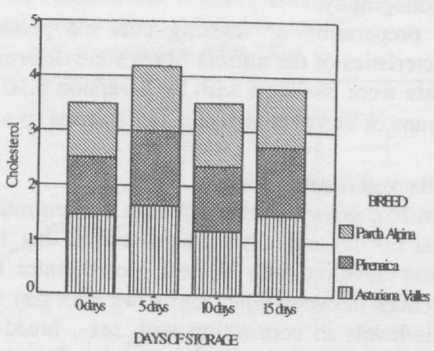

Fig. 3.- Cholesterol content (O.D. x mm)

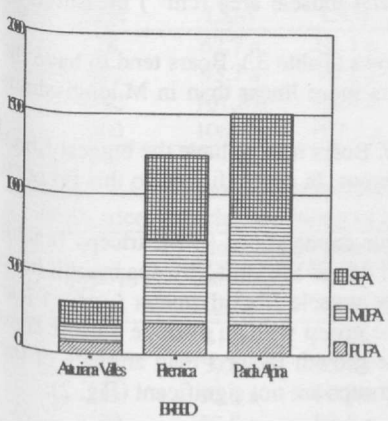

Fig. 4.-Fatty acids content (mg of FA/100 g of meat)

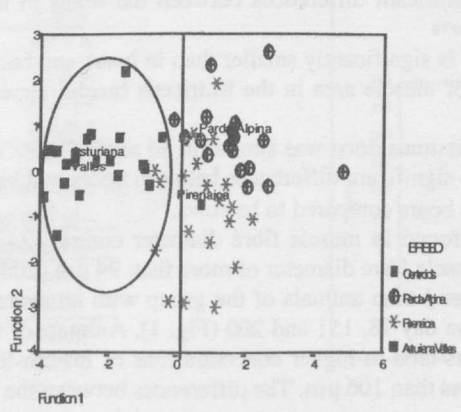

Fig. 5.- Separation of "breed" groups obtained using the stepwise discriminant analysis

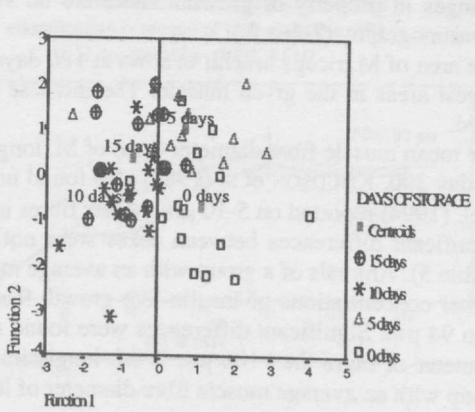

Fig. 6.- Separation of "days of storage" groups obtained using the stepwise discriminant analysis