# FAT COMPOSITION OF YOUTHFUL AND MATURE BEEF IN NORTHERN SPAIN

Magdalena Aurtenetxe[1], Leire Bravo-Lamas[1], Xabier Belaunzaran[1], David Gamarra[2], Luis J. R. Barron[1], John K. G. Kramer[3] and Noelia Aldai[1]

[1]Department of Pharmacy & Food Sciences, Lactiker Research Group, [2]Biomics Research Group; Lascaray Research Center, UPV/EHU, 01006, Vitoria-Gasteiz, Spain (noelia.aldai@ehu.eus)

[3]Guelph Food Research Centre, Agriculture & Agri-Food Canada, Guelph, ON, Canada.

**Abstract – The present work was undertaken to compare the FA composition of backfat tissue from mature beef (over 30 months of age, Friesian) and physiologically youthful beef under 30 months of age from two breeds (Pirenaica, Salers) to determine distinguishing characteristics between carcasses based on more desirable FA compositions. Adipose tissue from mature Friesian carcasses possessed FA profiles strongly suggesting the consumption of greater amounts of forage versus concentrate. Specially these carcasses provided higher relative abundance of vaccenic and rumenic acids and 11*t*,13*c*-18:2, and lower levels of undesirable *trans*-FAs which may provide opportunities for value added beef marketing.**

**Key Words – cattle, CLA, cull cow, *trans* fatty acids.**

## I. INTRODUCTION

The fat content and fatty acid (FA) composition of beef are characteristic indicators of quality consumers consider important when choosing healthy and nutritional commercial foods [1]. Beef cows are culled from the herd for a variety of reasons, including reproductive failure, age and unsatisfactory performance. These cows usually produce carcasses of insufficient conformation and most of their primal cuts are processed into ground beef [2]. To get higher revenue from these animals some have opted to feed high-energy diet to these cows to improve carcass composition and increase intramuscular fat content [2-4]. Other have opted to recover value from beef over 30 months (mo) of age by identifying characteristics that are either equivalent or superior to beef from animals under 30 mo of age. Dugan *et al*. [5] investigated the adipose tissue from beef carcasses over 30 mo of age and found that they possess a FA profile healthier to that of conventionally finished beef that strongly suggests consumption of greater amounts of forage.

In several countries like France, beef consumption from cull cows is considerable [6]. In the Basque Country & Navarra (northern Spain) mature cattle are normally culled from dairy herds after the productive life while the main beef production comes from young bulls. Several studies have been performed comparing dairy/beef cattle quality attributes [7] or FA composition of Pirenaica yearling bulls [8], but no comprehensive surveys of the FA composition with specific emphasis on the *trans*-18:1 and CLA profile of mature and youthful beef cattle have been done.

The present work was, therefore, undertaken to compare the FA composition of backfat tissue from mature beef (>30 mo, Friesian) and physiologically youthful beef under 30 mo of age from two breeds (Pirenaica, Salers) to determine distinguishing characteristics between carcasses based on more desirable FA compositions.

## II. MATERIALS AND METHODS

The survey consisted of collecting bovine backfat samples from animals slaughtered in a commercial abattoir located in the Basque Country, northern Spain (Urkaiko S. Coop., Zestoa, Gipuzkoa, Spain). Samples were obtained from the left half carcasses, between the 5th-6th ribs, during 12 arbitrary days over 5 weeks in June-July of 2014. A total of 160 samples from pure breed cattle were collected from which production details were unknown: 115 Pirenaica, 13 Salers, 6 Asturiana, 2 Limousin and 24 Friesian cattle. Based on the number of animals within each breed and the age of slaughter, three commercial groups were established for comparison purposes: 1) carcasses from Pirenaica breed with <30 mo (n=104); 2) carcasses from

Salers breed with <30 mo (n=13); and 3) carcasses from Friesian cull cows with >30 mo of age at slaughter (n=24). In order to reduce differences in the size of the commercial groups, only 20 of the 104 Pirenaica carcasses were selected at random using the IBM SPSS Statistics.

During each collection, backfat samples were stored in zipp-lock plastic bags and transported in insulated coolers to the laboratory located in the Lascaray Research Center (Vitoria-Gasteiz, Spain). Samples were stored at -80ºC.

Fifty mg of fat tissue were weighed, freeze-dried and direct-methylated with sodium methoxide [9]. For quantitative purposes, internal standard (23:0ME) was added. Fatty acid methyl esters (FAME) were analyzed by GC/FID using a 100m SP2560 column with two complementary GC temperature programs [10,11]. Samples were subjected to a second GC/FID analysis using a 100m ionic liquid SLB-IL111 column [12] to determine several CLA and FAMEs isomers that co-eluted on the SP2560 column. FAMEs were identified using several reference standards (NuCheck Prep Inc., Supelco, Matreya and Larodan), fractions of FAMEs obtained by $Ag^+$ solid phase extraction [10,13], and retention times and elution orders reported in the literature [14]. Statistical analysis was carried out using IBM SPSS Statistics 22 for Windows.

## III. RESULTS AND DISCUSSION

The average age at slaughter for Friesian cattle was 69.5 mo (>30 mo) while the other two breeds (Pirenaica and Salers) were slaughtered at 12 mo (<30 mo) (Table 1).

Table 1. Least square means and maximum and minimum values of age at slaughter and carcass traits of subcutaneous fat samples from cattle sampled

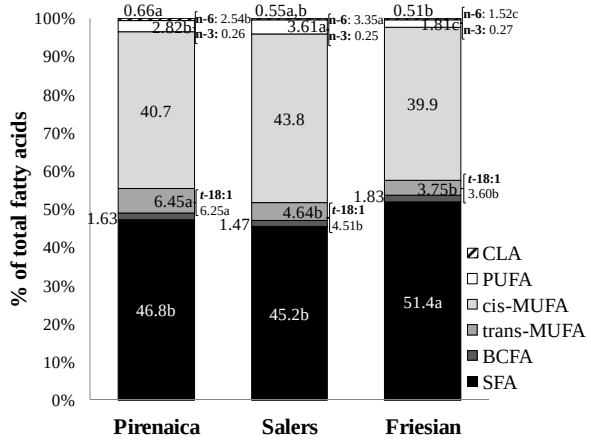
| | Pirenaica (n=20) | Salers (n=13) | Friesian (n=24) |
|---|---|---|---|
| Age at slaughter (month) | $12.3^{b}$ (10.2-14.2) | $12.6^{b}$ (10.3-14.0) | $69.5^{a}$ (31.2-112) |
| Cold carcass weight (kg) | $293^{ab}$ (235-338) | $324^{a}$ (286-357) | $285^{b}$ (191-397) |
| Conformation | $10.6^{a}$ (8-13) | $8.46^{b}$ (8-10) | $3.13^{c}$ (1-6) |
| Fat cover | $5^{ab}$ (2-7) | $5.69^{a}$ (5-7) | $3.79^{b}$ (1-9) |

$^{a-c}$within a row, means without a common superscript differ $P \leq 0.05$.

Significant carcass differences were observed between the 3 commercial types. Salers provided the heaviest carcasses (324 kg) with intermediate conformation and highest fat cover degree in comparison to the other two commercial types. Pirenaica's were intermediate in carcass weight (293 kg) with the best conformation and intermediate fat cover degree, while Friesian carcasses were the lightest (285 kg) with poor conformation and fat cover degree.

Differences in FA groups among the three commercial types are represented in Figure 1.

Figure 1. Least square means for fatty acid groups (%) of backfat from the three commercial types (Pirenaica, Salers & Friesian)

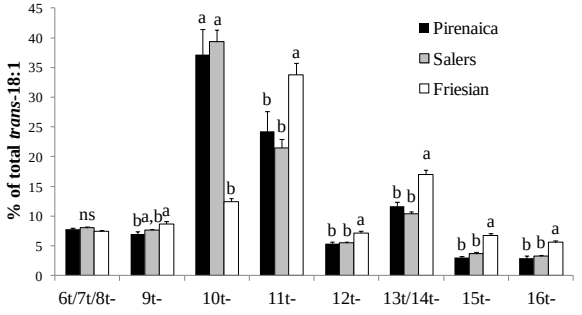



Backfat samples obtained from mature Friesian cattle provided the highest content of saturated FAs (SFA, 51.4%) compared to the other two breeds (average of 46%; $P \leq 0.001$); 16:0 and 18:0 were the main SFA in all of them. No significant differences between commercial types were observed for the branched-chain FA and *cis*-monounsaturated FAs (*cis*-MUFA) contents ($P > 0.05$; average values of 1.64% and 41.5%, respectively). Significant differences were, however, observed for the total *trans*-MUFA, influenced mainly by *trans*-18:1 ($P \leq 0.001$), and for CLA ($P \leq 0.01$) contents. In general, Friesian carcasses provided the lowest contents (3.75% and 0.51%), Pirenaica carcasses provided the highest (6.45% and 0.66%), and Salers carcasses provided intermediate values (4.64% and 0.55% for *trans*-MUFA and CLA, respectively). Opposite to the SFA content, the polyunsaturated FA (PUFA) content was the lowest in Friesian (1.81%), highest

in Salers (3.61%) and intermediate in Pirenaica carcasses (2.82%; $P \leq 0.001$). These differences were associated with the n-6 PUFA content, while the n-3 PUFA content was not significantly different between these commercial types.

The relative isomeric distribution of *trans*-18:1 isomers relative to the total *trans*-18:1 content is shown in Figure 2.

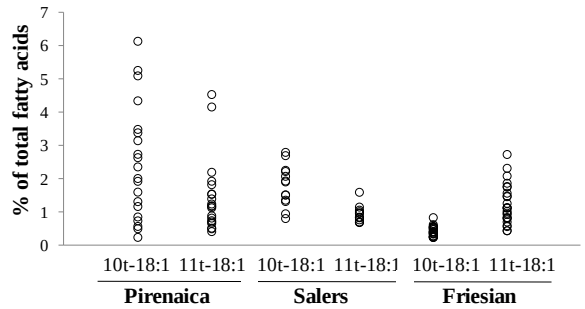
Figure 2. Relative isomeric distribution of individual *trans*-18:1 isomers of backfat from the three commercial types (Pirenaica, Salers & Friesian)




Mature Friesian carcasses not only had the lowest total *trans*-18:1 content but provided the highest relative percentage of all isomers except 10*t*-18:1, which was the lowest. No significant differences were observed for 6*t*/7*t*/8*t*-18:1. The pattern of *trans*-18:1 isomers in carcasses of youthful animals was similar to previous findings for adipose tissue from youthful beef fed high levels of concentrate [8,12,16].

In general, the variability of the two major *trans*-18:1 isomers (10*t*- and 11*t*-18:1 or vaccenic acid, VA) was highest in Pirenaica carcasses in comparison to the other two commercial types (Figure 3).

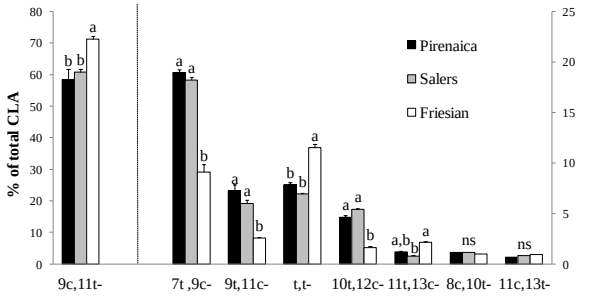
Figure 3. Variation of the relative abundance of 10*t*- and 11*t*-18:1 (% of total fatty acids) of backfat from the three commercial types (Pirenaica, Salers & Friesian)




This could be attributed to several factors. For example, most of the producers have Pirenaica as their main breed while the Salers breed is probably coming from a single or few producers and therefore the variability is smaller. It is of interest to note that the variation of 10*t*-18:1 isomer is greater than the variation of 11*t*-18:1 in cattle under 30 mo of age (Pirenaica, Salers), but opposite in cattle over 30 mo (Friesian).

The relative distribution of CLA isomers relative to the total CLA content is represented in Figure 4. Rumenic acid (RA, 9*c*,11*t*-18:2) was the most abundant CLA isomer in all commercial types and was significantly higher in Friesian carcasses compared to the other commercial types. 7*t*,9*c*-18:2 was the second most abundant isomer in youthful cattle (Pirenaica and Salers), while the total of *t*,*t*-CLA was highest in Friesian carcasses. 9*t*,11*c*- and 10*t*,12*c*-18:2 isomers were the greatest in youthful animals while 11*t*,13*c*-18:2 isomer was the greatest in mature Friesian carcasses.

Figure 4. Relative isomeric distribution of individual CLA isomers of backfat from the three commercial types (Pirenaica, Salers & Friesian)




## IV. CONCLUSION

Adipose tissue from mature Friesian carcasses (>30 mo) possessed FA profiles strongly suggesting the consumption of greater amounts of forage versus concentrate. Specially these carcasses provided higher relative abundance of VA, RA and 11*t*,13*c*-18:2, and lower levels of undesirable *trans*-FAs which may provide opportunities for value added beef marketing. The adipose fat of Pirenaica and Salers breeds contained appreciable amounts of 10*t*-18:1 and the CLA isomers 7*t*,9*c*-, 9*t*,11*c*- and 10*t*,12*c*-18:2. Modifications in feeding practices would be needed to improve their fat profile.

## ACKNOWLEDGEMENTS

M.A., X.B. and D.G. thank the Dept. of Economic Development & Competitiveness of the Basque Government for their fellowships. L.B.L. thanks the Dept. of Education, Language Policy & Culture of the Basque Government for her fellowship. N.A. thanks the Spanish Ministry of Economy & Competitiveness and the UPV/EHU for the 'Ramón y Cajal (RYC-2011-08593)' contract. This work was supported by the grants from the Dept. of Education, Universities & Research of the Basque Government (IT766-13 & IT833-13). The help provided by J.P. Larrea and staff from Harakai-Urkaiko is very much appreciated.

## REFERENCES

1. Scollan, N., Hocquette, J. F., Nuernberg, K., Dannenberger, D., Richardson, I. & Moloney, A. (2006). Innovations in beef production systems that enhance the nutritional and health value of beef lipids and their relationship with meat quality. Meat Science 74: 17-33.
2. Cranwell C. D., Unruh J. A., Brethour, J. R., Simms D. D. & Campbell, R. E. (1996). Influence steroid implants and concentrate feeding on performance and carcass composition of cull beef cows. Journal of Animal Science 74: 1770-1776.
3. Franco, D., Bispo, E., González, L., Vázquez, J. A. & Moreno, T. (2009). Effect of finishing and ageing time on quality attributes of loin from the meat of Hostein-Fresian cull cows. Meat Science 83: 484-491.
4. Price, M. A. & Berg, R. T. (1981). On the consequences and economics of feeding grain *ad libitum to* culled beef cows. Canadian Journal of Animal Science 61: 105-111.
5. Dugan, M. E. R., Rolland, D. C., Aalhus, J. L., Aldai, N. & Kramer, J. K. G. (2008). Subcutaneous fat composition of youthful and mature Canadian beef: emphasis on individual conjugated linoleic acid and *trans*-18:1 isomers. Canadian Journal of Animal Science 88: 591-599.
6. Jurie, C., Picard, B., Hocquette, J. F., Dransfield, E., Micol, D., & Listrat, A. (2007). Muscle and meat quality characteristics of Holstein and Salers cull cows. Meat Science 77: 459-466.
7. Lizaso, G., Beriain, M. J., Horcada, A., Chasco, J., & Purroy, A. (2011). Effect of intended purpose (dairy/beef production) on beef quality. Canadian Journal of Animal Science 91: 97-101.
8. Indurain, G., Beriain, M. J., Goñi, M. V., Arana, A. & Purroy, A. (2005). Composition and estimation of intramuscular and subcutaneous fatty acid composition in Spanish young bulls. Meat Science 73: 326-334.
9. Kramer, J. K. G., Fellner, V., Dugan, M. E. R., Sauer, F. D., Mossoba, M. M. & Yurawecz, M. P. (1997). Evaluating Acid and Base Catalyst in the Methylation of Milk and Rumen Fatty Acids with Special Emphasis on Conjugated Dienes and Total *trans* Fatty Acids. Lipids 32: 1219-1228.
10. Dugan, M. E. R., Kramer, J. K. G., Robertson, W. M., Meadus, W. J., Aldai, N. & Rolland, D. C. (2007). Comparing Subcutaneous Adipose Tissue in Beef and Muskox with Emphasis on *trans* 18:1 and Conjugated Linoleic Acids. Lipids 42: 509-518.
11. Kramer, J. K. G., Hernandez, M., Cruz-Hernandez, C., Kraft, J. & Dugan, M. E. R. (2008). Combining Results of Two GC Separations Partly Achieves Determination of All *cis* and *trans* 16:1, 18:1, 18:2 and 18:3 Except CLA Isomers of Milk Fat as Demonstrated Using Ag-Ion SPE Fractionation. Lipids 43: 259-273.
12. Delmonte, P., Fardin Kia, A. R., Kramer, J. K. G., Mossoba, M. M., Sidisky, L. & Rader, J. I. (2011). Separation characteristics of fatty acid methyl esters using SLB-IL111, a new ionic liquid coated capillary gas chromatographic column. Journal of Chromatography A 1218: 545-554.
13. Belaunzaran, X., Bravo-Lamas, L., Kramer, J. K. G. & Aldai, N. (2014). Limitations of using silver ion solid-phase extraction for animals lipids with a low *trans* content. European Journal of Lipid Science and Technology 116: 1621-1625.
14. Aldai, N., de Renobales, M., Barron, L. J. R., & Kramer, J. K. (2013). What are the *trans* fatty acids issues in foods after discontinuation of industrially produced *trans* fats? Ruminant products, vegetable oils, and synthetic supplements. European Journal of Lipid Science and Technology 115: 1378-1401.
15. Aldai, N., Dugan, M. E. R., Juárez, M., Martínez, A. & Osoro, K. (2010). Double-muscling carácter influences the *trans*-18:1 and conjugated linoleic acid profiles in concentrate-fed yearling bulls. Meat Science 85: 59-65.