71st ICoMST
GIRONA - CATALONIA - SPAIN
3rd-8th August - 2025

IMPACT OF DIET ON DIAPHRAGM LIPID COMPOSITION FROM BOVINE FEMALES OF VARIOUS AGES

M.-P. Ellies-Oury[1,2,3*], S. Papillon[1], A. Listrat[2], D. Andueza[2], C.E. Realini[3*]

[1] INRAE, VetAgroSup; UMR1213, Saint-Genès Champanelle, France

[2] Bordeaux Sciences Agro, Grdignan, France

[3] AgResearch Ltd., Te Ohu Rangahau Kai, Palmerston North, New Zealand

*Corresponding author emails: marie-pierre.ellies@agro-bordeaux.fr and carolina.realini@agresearch.co.nz

I. INTRODUCTION

It is commonly reported that, compared to animals fattened with higher concentrate diets, the meat of animals raised on pasture is significantly leaner and richer richer in n-3 and antioxidants, while containing lower levels of n-6 fatty acids [1]. This profile contributes to the superior nutritional properties and health value of meat from pasture-fed animals [2], including an n-6/n-3 ratio that aligns more closely with ANSES recommendations [3]. In a context where it is becoming necessary to reflect collectively on the design of animal husbandry methods that mitigate their negative impacts and further develop positive externalities and services [4], this study aimed to evaluate the nutritional properties of meat from animals reared extensively on grassland farms compared with more intensive feeding systems. **Two questions arise: are the nutritional properties equivalent regardless of 1/ the main forage in the finishing diet (grazed or established meadow hay)? and 2/ the quantities and nature of the concentrates added to the ration?**

II. MATERIALS AND METHODS

After a one-month adaptation period during which the animals received an equivalent diet, the cows were assigned to one of four finishing diets: 1/ grazed fresh grass + 3 kg of cracked corn grain (G3), 2/ hay + 3 kg of cracked corn grain (H3), 3/ hay + 10 kg of cereals (1/3 maize, 1/3 barley, 1/3 wheat) + 16%N protein concentrate (H10), or 4/ hay +10 kg of cereals (1/3 maize, 1/3 barley, 1/3 wheat) + 16%N protein concentrate + flax seed (H10F). After a 4-month finishing period, all animals were slaughtered in the same commercial abattoir. Carcass weight, fat cover, conformation and ultimate pH were recorded. Animal carcasses were assessed according to the EUROP grid (conformation scores were converted into a continuous 15-point scale) [5]. *Diaphragm* muscle samples were collected 24 hours post-mortem and frozen until further analysis. The fatty acids (FAs) were extracted from total lipids and subsequently transmethylated to methyl esters (FAMEs), which were then analyzed with GC using a Peri 2100-chromatography system (Perichrom, Saulxles-Chartreux, France) with a CP-Sil 88 glass capillary column (Varian, Palo Alto, CA; length-100m, diam-0.25mm). The carrier gas was H^2 and the temperatures of oven and flame ionization detector were set according to [6]. An internal standard of C19:0 was used to calculate total FAs. Using a C4-C24 FAME quantitative mix (Supelco, Bellafonte, PA, USA), each individual FAME was identified, and the response coefficients were calculated. The FAs were grouped according to whether they were saturated (SFA), monounsaturated (MUFA) or polyunsaturated (PUFA) and whether they belonged to the n-3 or n-6 group. Differences between diets were tested using R 4.2.1. and a 1-factor analysis of variance.

III. RESULTS AND DISCUSSION

Regardless of finishing diet, all ultimate pH values were below 6.0, although the carcasses from the H10 cows had higher ultimate pH values than H3 and G3 (Table 1).
After a finishing period of 4 months, the H10F cows produced heavier (379 vs 323 and 335 kg) and fatter carcasses (3.00 vs 2.57 and 2.30 out of 5) than H3 and G3 respectively, with H10 being intermediate (358 kg and 2.77 out of 5). This confirms the favourable effect of higher energy intake in the ration on animal growth and carcass adiposity, as previously reported by [7].
The lipid percent of the *Diaphragm* muscle follows the same trend as that of carcass adiposity, with cows fattened on the H10F diet producing meat with significantly higher lipid percent (7.73 g/100g) than G3 and H3 cows (5.22 and 5.11 g/100 g, respectively), and H10 cows being intermediate (5.57 g/100g).
The literature commonly reports that grass feeding increases SFA, while grain feeding increases MUFA [8]. In our study, with the same fat content, the G3 muscles have significantly higher proportions of SFAs and lower MUFAs ones than those of H3 and H10 diets. Muscles from H10F have significantly lower PUFAs than those from H3, confirming the dilution of PUFAs in the total FAs when lipid content increases. In line with findings commonly reported in the literature [X], meat from grass-fed animals (G3) had higher proportions of n-3 than meat from H10 and H10F, as well as lower proportions of n-6 than H10 muscles. It is interesting to note that the n-3 proportions and n-6/n-3

ratios of meat from animals fed G3 and H3 diets are comparable (fresh grazed grass and hay), which indicates that forage drying had limited impact on the nutritional value of meat when considering total lipid percentage, n-3 proportions and n-6/n-3 ratio. However, this finding contrasts with results generally found in the literature [8], possibly due to the high nutritional quality of the meadow hay and an optimal drying process.
Results also show that the addition of flaxseed to the diet (H10F *vs* H10) enhances the fatty acid profile by decreasing the n-6/n-3 ratio under the recommended threshold value of 4 indicated by the health authorities [9].

Table 1 - Carcass characteristics and lipid percent and fatty acid composition of *Diaphragm* muscle according to cow finishing diet.

Finishing diet	**G3**[3]	**H3**[3]	**H10**[3]	**H10F**[3]	**P-value**[4]
Number of animals	20	19	26	18	
Age (years)	8.4	8.7	8.4	6.4	ns
Cold Carcass Weight, kg	335 bc	**323 c**	358 ab	**379 a**	***
Fat score[1]	**2.30 c**	2.57 bc	2.77 ab	**3.00 a**	***
Conformation[1]	**6.95 b**	**6.68 b**	**7.77 a**	**8.28 a**	***
Ultimate pH	5.77 b	**5.60 c**	**5.91 a**	5.78 ab	***
Diaphragm lipid and fatty acid composition					
IMF[2] (g / 100 g muscle)	**5.22 b**	**5.11 b**	5.57 ab	**7.73 a**	***
SFA[2] (% FA)	**56.8 a**	**53.3 b**	**54.4 b**	55.3 ab	**
MUFA[2] (% FA)	**34.2 b**	**37.1 a**	**37.6 a**	36.5 ab	**
PUFA[2] (% FA)	**4.79 b**	**5.73 a**	5.09 ab	**4.53 b**	**
n-3[2] (% FA)	**1.24 a**	**1.36 a**	**0.77 b**	**0.90 b**	***
n-6[2] (% FA)	**3.03 b**	**3.76 a**	**3.79 a**	3.26 ab	**
n-6 / n-3	**2.53 c**	**2.85 c**	**5.20 a**	3.67 b	***

[1] Fat score expressed between 1 (extremely lean) and 5 (extremely fatty); Conformation expressed between 1 (poor conformation) and 15 (superior) ; [2] IMF: intramuscular fat percentage; SFA: Saturated fatty acids (∑ C10:0, C12:0, C14:0, C15:0, C16:0, C17:0, C18:0, C20:0, isoC15:0, anteisoC15:0, isoC16:0, isoC17:0, anteisoC17:0), MUFA: Monounsaturated fatty acids (∑C14:1, C16:1, C17:1, C18:1:t9, C18:1:t11, C18:1:c9, C18:1:c11), PUFA: Polyunsaturated fatty acids (∑C18:2:n6, C18:3:n3, CLAc9t11, C20:3:n6, C20:4:n6, C20:5:n3, C22:5:n3, C22:6:n3); n-3: ∑ C18:3:n3, C20:5:n3, C22:5:n3, C22:6:n3; n-6: ∑ C18:2:n6, C20:3:n6, C20:4:n6 ; [3] G3: grazed fresh grass + 3 kg of cracked corn grain, H3: hay + 3 kg of cracked corn grain, H10: hay + 10 kg of cereals (1/3 maize, 1/3 barley, 1/3 wheat) + 16%N protein concentrate, H10F: hay +10 kg of cereals + 16%N protein concentrate + flax seed ; [4] ns : p>0,05 ; ** : p<0,01 ; *** : p<0,001

CONCLUSION

Our results confirm that meat from animals fed mainly on grass or hay, with minimal concentrate, exhibits a more favourable lipid profile, higher n-3 percent and a balanced n-6/n-3 ratio, in line with nutritional recommendations for a healthy diet compared with meat from animals fed high levels of concentrate. While high levels of concentrates in hay-based finishing diets can negatively impact the n-6/n-3 ratio by increasing the value above the critical threshold of 4, the addition of flax seed significantly improves the nutritional quality of the meat. Thus, by adjusting the type of concentrates included in the diet, it is possible to modulate the nutritional profile of meat to align with health authority recommendations while ensuring optimal carcass development in terms of weight, fatness, and conformation. In a context where consumers are increasingly concerned about the environmental impact of production, it will be essential to formulate finishing diets that incorporate locally and sustainably produced concentrates. Additionally, further research should examine how these diets influence the sensory properties of meat, a key factor in both initial purchase and repeat purchase decisions.

ACKNOWLEDGEMENTS

This work was conducted as part of the Watson project, funded by the European Union's Horizon Europe research and innovation programme, under grant agreement No. 101084265. This research was part of the International Associated Laboratory (LIA) - RUMQUAL project (Real time assessment and modelling of meat QUAlity from RUMinants) co-funded by INRAE and BSA in France and AgResearch in New Zealand.

REFERENCES

[1] A. Clinquart, M. P. Ellies-Oury, J. F. Hocquette, L. Guillier, V. Santé-Lhoutellier, et S. Prache, « Review: On-farm and processing factors affecting bovine carcass and meat quality », *Animal*, vol. 16, p. 100426, févr. 2022, doi: 10.1016/j.animal.2021.100426.
[2] K. M. C. Nogoy *et al.*, « Fatty Acid Composition of Grain- and Grass-Fed Beef and Their Nutritional Value and Health Implication », *Food Sci Anim Resour*, vol. 42, nº 1, p. 18-33, janv. 2022, doi: 10.5851/kosfa.2021.e73.
[3] H. Davis, A. Magistrali, G. Butler, et S. Stergiadis, « Nutritional Benefits from Fatty Acids in Organic and Grass-Fed Beef », *Foods*, vol. 11, nº 5, p. 646, 2022, doi: https://doi.org/10.3390/foods11050646.
[4] B. Dumont *et al.*, « Rôles, impacts et services issus des élevages en Europe. Rapport d'expertise scientifique collective réalisé à la demande des ministères en charge de l'Environnement et de l'Agriculture, et de l'Ademe », 2016.
[5] J. Liu *et al.*, « European conformation and fat scores of bovine carcasses are not good indicators of marbling », *Meat Science*, vol. 170, nº June, p. 108233, 2020, doi: 10.1016/j.meatsci.2020.108233.
[6] V. Scislowski, D. Durand, D. Gruffat, et D. Bauchart, « Dietary Linoleic Acid-Induced Hypercholesterolemia and Accumulation of Very Light HDL in Steers », *Lipids*, vol. 39, nº 2, p. 125-133, févr. 2004, doi: 10.1007/s11745-004-1210-x.
[7] D. W. Pethick, G. S. Harper, et V. H. Oddy, « Growth, development and nutritional manipulation of marbling in cattle: a review », *Australian Journal of Experimental Agriculture*, vol. 44, nº 7, p. 705-715, 2004.
[8] J. Normand et D. Gruffat, « Fattening cattle with grass-based diets improves the nutritional quality of fatty acids in beef », *Cahiers Nutrition Diététique*, vol. 58, nº 1, p. 53-69, 2023, doi: https://doi.org/10.1016/j.cnd.2022.07.004.
[9] AFSSA, « Avis de l'agence française de sécurité sanitaire des aliments relatif à l'actualisation des apports nutritionnels conseillés pour les acides gras (saisine no 2006-SA-0359). », 2010.