EFFECT OF FEEDING PLAN AND GENOTYPE ON FATTY ACID COMPOSITION OF VEAL

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Abstract – The aim of this study was to evaluate the effects of feeding plan and genotype on fatty acid profile of veal. Thirty-two male calves, 16 purebred Friesian and 16 beef x dairy crossbreds, reared in the same farm, were fed on milk replacer (1.9 kg milk powder/calf/day) and maize silage (0.3 kg/calf/day). Within each genotype group, half of calves were supplemented with 0.4 kg/calf/day of maize grain while the others were supplemented with 0.6 kg/calf/day. The animals were slaughtered at an average age and weight of 6 months and 276 kg respectively. At 1 day *post mortem* samples of *longissimus thoracis* muscle were taken from the right half carcass between the 8th and 10th rib. Fat content and fatty acid composition were determined. There was no effect of diet on fat content and fatty acid profile of veal. Breed variations (P<0.05) in meat fatty acid composition were observed for some individual fatty acids (myristic, myristoleic, palmitic and stearic acid) and for the total saturated fatty acids. From a human health standpoint, fatty acid composition of *longissimus thoracis* muscle of crossbred has a positive impact on human nutrition as confirmed by a better polyunsaturated/saturated ratio and lower atherogenic and trombogenic indices.

Key Words – breed calves, fibrous feed supplementation, meat lipid quality

I. INTRODUCTION

The calves, reared and slaughter at a final live weight of 260-290 kg for the production of tender and light meat, represent in Italy a very important sector of cattle production.

The breeds for veal production, are mainly Italian Friesian or Brown male coming from dairy farms but also some beef x dairy crossbreds are used [1, 2]. In the past, the feeding plan of veal calves was based on the provision of a milk replacer diet without any addition of solid feeds. The European Council Directive 97/2/EC [3], to fulfil the physiological needs of the calves, dictates that calves must be feed with increasing amounts of fibrous feed in addition to the all-liquid diet. Therefore, in order to assure an adequate meat paleness and to guarantee an acceptable calves health, maize silage and maize grain are the most used solid feeds in the fattening units.

It is well known that factors such as age or slaughter weight, genotype and diet, have an important influence on meat quality and, in particular, on fat content and on its fatty acid composition.

As the lipid fraction is of major importance to characterize meat nutritional quality, the aim of this study was to evaluate the effects of feeding plan and genotype on veal nutritional quality.

II. MATERIALS AND METHODS

Thirty-two male calves, 16 purebred Friesian (F) and 16 beef x dairy crossbreds (C), reared in the same farm, were used. All the animals were fed milk replacers (1.9 kg milk powder/calf/day) and maize silage (0.3 kg/calf/day) and, within each genotype, half of calves were supplemented with 0.4 kg/calf/day (T1) of maize grain, while the others were supplemented with 0.6 kg/calf/day (T2).

A Starter milk replacer containing 18% of crude fat, 63% of saturated fatty acid (SFA), 32% of monounsaturated fatty acid (MUFA) and 5% of polyunsaturated fatty acid (PUFA) was used in the first 4 weeks; for the following 22 weeks calves received a Finisher milk replacer contained 21% of crude fat, 61% of SFA, 32% of MUFA and 7% of PUFA.

Among the various solid feeds suitable for veal calf feeding, maize silage was chosen for its wide availability and maize grain for its low iron concentration which permit to utilize high quantity of cereal without negative consequences on meat colour.

The animals were slaughtered in the same slaughterhouse at an average age and weight of 6 months and 276 kg respectively.

Twenty-four hours after slaughter samples of *longissimus thoracis* muscle from the right half carcass were taken between the 8th and 10th rib. The samples were stored at 4°C for seven days and then freeze-dried.

Fat content was analysed according to the Association of Official Analytical Chemists [4].

Fatty acid composition was determined after lipid extraction [5] and methylation procedure [6] by gas-chromatography (SHIMADZU - GC 17A) using a HP88 capillary column (100 m x 0.25 mm ID, 0.2 μm film thickness; J&W Scientific). The column temperature was held at 60°C for 1 min and then raised 20°C min^{-1} to a final temperature of 190°C, where it remained for 40 minutes. Temperature of the injector and flame-ionization detector were maintained at 250 and 280°C, respectively; the injection volume was 0.1 μl. Peaks were identified by comparing the retention times with pure fatty acid methylester (FAME) standards (Matreya Inc., Pleasant Gap, PA, USA and Restek Corporation, Bellefonte, PA, USA). Intramuscular FAME were expressed as percentage of total FAME detected. The concentration of fatty acids (mg/100 g of edible portion) was calculated using the total fat conversion factor reported by Greenfield and Southgate [7].

In order to evaluate the nutritional value of intramuscular fat n6/n3 and polyunsaturated/saturated fatty acids (PUFA/SFA) ratios were calculated. As lipid quality depend on the relative contents of particular groups of fatty acids, the atherogenic index (AI) and thrombogenic index (TI), were calculated according to Ulbricht and Southgate [8]:

AI=[C12:0+(4*C14:0)+C16:0]/[(ΣPUFA)+(ΣMUFA)];

TI=[C14:0+C16:0+C18:0]/[(0.5*ΣMUFA)+(0.5*Σn6)+(3*Σn3)+(n3/n6)].

The data were analysed using the GLM procedure of the SPSS statistical package [9] considering two fixed effects, diet (2 levels) and genotype (2 levels), and their interaction.

III. RESULTS AND DISCUSSION

The fat content, the fatty acid percentage (% of total fatty acids) and fatty acid concentrations (mg/100 g of meat) are reported in Tables 1 and 2.

Table 1 Fat content (%) and fatty acid composition (% of total fatty acids) of veal *longissimus thoracis* muscle (F: Friesian; C: crossbred; T1: 0.4 kg/calf/day of maize grain; T2: 0.6 kg/calf/day of maize grain; SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; CLA: conjugated linoleic acid; PUFA: polyunsaturated fatty acid. P: *:<0.05; ns: not significant).

	Breed			Diet		
%	F	C	P	T1	T2	P
Fat	1.70	1.21	ns	1.59	1.33	ns
C14:0	6.95	6.06	ns	6.74	6.82	ns
C16:0	27.73	27.35	ns	27.38	27.69	ns
C18:0	14.72	14.47	ns	14.55	14.64	ns
C20:0	0.14	0.10	ns	0.13	0.11	ns
Σ SFA	49.53	48.53	*	48.79	49.26	ns
C14:1	0.83	0.75	ns	0.84	0.73	ns
C16:1	3.40	3.32	ns	3.33	3.39	ns
C18:1	38.91	39.33	ns	39.39	38.85	ns
Σ MUFA	43.14	43.40	ns	43.56	42.98	ns
C18:2n6	6.63	7.36	ns	6.95	7.04	ns
C18:3n3	0.31	0.31	ns	0.31	0.32	ns
CLA *c*9*t*11	0.40	0.41	ns	0.39	0.41	ns
Σ PUFA	7.34	8.08	ns	7.65	7.77	ns

Fat content and fatty acid composition of *longissimus thoracis* muscle were not influenced by the diet. These results are partially in agreement with those of other authors [10, 11, 12] who reported that the use of fibrous feeds in partial substitution or in addition to milk diet, caused no differences or increased fat content of meat.

As regard fatty acids, Xiccato et al. [12] found a lower proportion of C16:0 and a higher percentage of C18:2n6 and C18:3n3, in calves fed exclusively milk replacers compared to calves supplemented with maize grain.

Concerning breed, F and C calves did not differ in fat content (P= 0.058).

Stearic (C18:0) and palmitic (C16:0) acids as SFA, oleic acid (C18:1) as MUFA and C18:2n6 as PUFA were the main fatty acids in veal *longissimus thoracis* muscle contributing to more than 88% of total fatty acid.

The F group showed a significantly higher percentage (P<0.05) of SFA than the C group due to the slightly higher percentages, even if not significant, of all saturated fatty acids. This fatty acid profile is a consequence of milk fatty acids being scarcely altered on passing through the rumen, since veal calves behave monogastrically as far as digestive processes are concerned. From a health point of view, a high SFA intake is widely believed to contribute to the development of coronary heart disease.

This situation was more evident considering veal fatty acid composition expressed as absolute value (Table 2).

Table 2 Fatty acids composition (mg/100g of meat) of veal *longissimus thoracis* muscle (F: Friesian; C: crossbred; T1: 0.4 kg/calf/day of maize grain; T2: 0.6 kg/calf/day of maize grain; SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; CLA: conjugated linoleic acid; PUFA: polyunsaturated fatty acid. P: *:<0.05, ns: not significant).

	Breed			Diet		
	F	C	P	T1	T2	P
C14:0	108.74	73.48	*	99.24	82.98	ns
C16:0	431.19	302.07	*	397.04	336.23	ns
C18:0	229.46	160.44	*	211.90	178.01	ns
C20:0	0.23	0.11	ns	0.21	0.12	ns
Σ **SFA**	771.65	537.08	*	710.30	598.43	ns
C14:1	12.90	8.04	*	12.09	8.84	ns
C16:1	53.89	37.36	ns	49.38	41.88	ns
C18:1	611.44	437.38	ns	574.17	474.66	ns
Σ **MUFA**	678.23	482.78	ns	635.64	525.38	ns
C18:2n6	98.97	79.58	ns	97.30	81.25	ns
C18:3n3	4.76	3.42	ns	4.39	3.80	ns
CLA *c*9*t*11	6.09	4.38	ns	5.52	4.95	ns
Σ **PUFA**	109.82	87.38	ns	107.21	89.99	ns

The F group had a higher content (P<0.05) of saturated fatty acids owing to a higher concentration (P<0.05) of C14:0, C16:0 and C18:0 than the C group. As regard monounsaturated fatty acids, the myristoleic acid (C14:1) content was higher (P<0.05) in F compared to C group while neither breed nor diet affected monounsaturated and polyunsaturated fatty acids.

Fatty acid ratios related to healthy human nutrition are shown in Table 3.

Table 3 Veal *longissimus thoracis* muscle fatty acid ratios related to human health (F: Friesian; C: crossbred; T1: 0.4 kg/calf/day of maize grain; T2: 0.6 kg/calf/day of maize grain; PUFA: polyunsaturated fatty acid, SFA: saturated fatty acid; AI: atherogenic index; TI: thrombogenic index. P:*:<0.05; ns: not significant).

	Breed			Diet		
	F	C	P	T1	T2	P
PUFA/SFA	0.15	0.17	*	0.16	0.16	ns
C18:2n6/C18:3n3	22.30	23.98	ns	22.96	23.33	ns
AI	1.11	1.05	*	1.07	1.09	ns
TI	1.91	1.84	*	1.86	1.90	ns

No differences due to the diet were observed.

Concerning breed, the C group had a significant higher PUFA/SFA ratio, and lower (P<0.05) atherogenic and thrombogenic indices than F meat. Since the PUFA/SFA ratio was in any case below 0.2, veal could be implicated in causing the imbalanced fatty acid intake for consumers. In fact current nutritional recommendations indicate that the PUFA/SFA ratio in human diets should be above 0.45; the low PUFA/SFA ratio in typical Western diets have been considered as major risk factors of cardiovascular diseases [13]. No differences between breeds were found for C18:2n6/C18:3n3 ratio. The high level of C18:2n6 observed in veal meat caused an undesirably high value of this ratio that should be less than 4.0 in relation with human health [13]. The right balance of n-6/n-3 ratio (usually expressed as the ratio of essential fatty acids C18:2n-6/C18:3n-3) plays an important role in the prevention of several chronic and other inflammatory or autoimmune disorders.

Kelava et al. [14] comparing Holstein-Friesian with a beef x dairy crossbred found significant different percentages of some individual saturated and unsaturated fatty acids. The veal of crossbreed had a higher unsaturated fatty acid content and a more favourable PUFA/SFA and n6/n3 ratios than Holstein-Friesian.

IV. CONCLUSION

In the present study, the fatty acid composition was not influenced by different supplementation with maize grain. On the contrary the genotype was an important source of variation for fatty acid composition of *longissimus thoracis* muscle. The intramuscular fat is a fundamental factor for fatty acid composition. In fact, even if not significant, the higher fat content of F group increased the saturated fatty acid concentration compared to C group.

From the nutritional point of view, crossbred meat seems to be more healthful than that of Friesian because of its higher PUFA/SFA ratio, although this ratio is below the recommended value for human diet, and its lower atherogenic and thrombogenic indices.

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