EFFECT OF BREED ON PROXIMATE COMPOSITION AND FATTY ACID COMPOSITION OF MEAT FROM ITALIAN CATTLE

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Abstract — Interest in meat fatty acid composition comes from interest in eating healthier meat, i.e. with a higher ratio of polyunsaturated (PUFA) to saturated fatty acids and a more favourable balance between n6 and n3 PUFA. The aim of this study was to compare three different bovine genetic types, Maremmana (MM), Chianina (CH) and Italian Holstein (FR) on the base of their nutritional fat properties. Meat fatty acid profile was determined by gas chromatography analysis. Main fatty acids and conjugated linoleic acid (CLA), saturated (SFA), monounsatured (MUFA) and polyunsatured (PUFA) total were reported. Analysis of obtained data showed Maremmana breed as a carrier of some good features in this sense (e.g., low saturated fatty acid content and high oleic acid contribution) allowing it to play an important role in meat cattle breed.

Keywords— meat quality, local breed, fatty acids

I. INTRODUCTION

Genetic effects are involved in the expression of most of the meat quality traits. Different cattle breeds offer different adaptability to variable environmental and feeding conditions. Beef breeds have been subject to a strong selection in the last decades reaching very high performances in meat production for quantity and quality. Anyway in Italy we must consider the presence of some autochthonous breed, resistant to infectious diseases, who are used or could be used for meat production purposes, e.g., Chianina and Maremmana, the first breed is very productive, due to its big somatic development and the last breed is less productive but more rustic and well suited to marginal environments of high hills. Chianina is probably the most important Italian beef breed, very appreciated by consumers. Maremmana breed is characterized by some favourable nutritional meat traits, with particular regard to fatty acids profile, even though, due to its multiple purpose aptitude, other specialized beef breed are often preferred by farmers and traders. On the other hand the use of Holstein male calves for fattening and meat production is very common. It is characterized by a fast growth and development and produces carcasses and meat fatter than typical beef breeds. In particular dairy breeds deposit more intramuscular fat in relation to total fat [1]. This characteristic strongly influences consumers who prefer meat with good nutritional and organoleptic properties [2]. From this point of view it is very important to reduce the saturated fatty acid intake and an increase of polyunsaturated fatty acids with particular regard to n3 (C18:3, C20:5 and C22:6). Beef contains significant levels of these PUFA [3]. Dairy breeds deposit more intramuscular fat in relation to total fat [1]. Yoshimura et al. [4] reported that breed type affected fatty acid composition of subcutaneous adipose tissue. Also diet interferes with lipids' composition and there is a similarity between fatty acid profile of meat and feed [5, 6], even though the response is relatively small, due to biohydrogenation activity of rumen micro-organisms [7, 8]. Aim of this study was to investigate the breed effect on fatty acids composition and some chemical aspect of meat from three cattle breed with different aptitude: Chianina, typical Italian beef breed, Maremmana, very rustic autochthonous breed and Holstein, the most common dairy breed.

II. MATERIALS AND METHODS

Eighty-two young bulls: 28 Chianina (CN), 28 Maremmana (MM) and 26 Italian Holstein (FR), were slaughtered at a variable age and final weight as a function of somatic development and commercial maturity (when 75 % of mature bull was reached). CN was 640 days and 720 kg, MM was 575 days and 615 kg, and FR was 539

days and 560 kg, on average. All animals were fed the same diet over the trial (unifeed ration including corn silage 58.24%, hay 15.48%, barley grain 10.79, corn grain 7.98 %, soybean meal 7.04 % plus vitamin and mineral supplement 0.47 %). At 24 h after slaughter, from the left side, a sample cut was taken from the 6th to 7th rib, weighed and dissected into muscle, fat and bone, tendons and noticeable blood vessels according to the method described by [9]. Weights of each constituent were recorded and expressed as percentage of entire rib weight.

Following analyses were performed on meat:

- Chemical composition (dry matter, fat, protein, ash) [10].
- Fatty acid profile: aliquot samples of 3 g were extracted using the Folch method [11]. Then fatty acids were methylated by KOH and hexane before performing gas-chromatography. Separation and quantification of the fatty acid methyl esters was carried out using a gas chromatograph (Agilent Technology 6898 N) fitted with a Supelco 2560 capillary column (100 m, 250 µm internal diameter and 0.20 µm film thickness) and using helium as a carrier gas. Individual fatty acids were identified by comparing their retention times with a standard fatty acid mix Supelco 37 (Sigma Chemical Co. Ltd., Poole, UK) ones. Fatty acids were expressed as a percentage of total fatty acids identified, and grouped as follows: saturated fatty acid (SFA), monounsaturated (MUFA) and polyunsaturated fatty acid (PUFA). Minor and unresolved fatty acids are not reported.
- Statistical analysis: data were analysed by GLM procedure of SAS [12] using a monofactorial model with breed as factors.

III. RESULTS AND DISCUSSION

At dissection, probably due to its faster growth [13] Holstein showed a higher amount of fat (+ 2 %) when compared with the mean of the other two breeds.

Meaningful nutritional differences came out between groups. Chemical composition of meat confirmed a higher adiposity of Holstein meat, while the lower value was registered in Chianina meat (2.45% vs. 1.87%; Tables 1 and 2).

Table 1. Carcass classification and tissue composition of longissimus muscle.

	Carcass Kg	Adiposity and conformation SEUROP	Meat %	Bone %	Fat %
CH	457.8^{a}	2.1(R)	65.56^{a}	22.98^{a}	11.45^{b}
MM	338.6^{b}	2.2(O)	64.88^{ab}	22.03^{b}	13.09^{ab}
FR	312.1^{b}	2.3(O)	63.06^{b}	22.7^{ab}	14.24^{a}
Mean	370.9	2.2	64.52	22.56	12.91
S.D.	46.64	0.48	2.850	1.482	2.586

Table 2. Chemical parameters of meat.

	Dry matter %	Ash %	Crude protein %	Fat %
CH	24.3	1.09	21.35	1.87^{b}
MM	24.6	1.14	21.41	2.04^{ab}
FR	24.7	1.12	21.10	2.45^{a}
Mean	25.5	1.12	21.29	2.11
S.D.	1.17	0.144	0.986	0.793

In Holstein (Table 3) we found a smaller content of SFA (C14:0 and C18:0 in particular). Stearic acid was more abundant in Chianina (+ 4.3% with respect to Maremmana). Among MUFA, Maremmana showed a higher content of C16:1 and C18:1. On the other hand Chianina resulted to contain more C18:2 and C18:3. Those fatty acids are precursors of n6 and n3 series and play a very important role in human health and heart diseases prevention [14].

The level of CLA in Chianina and Maremmana meat is noteworthy. This trait, even though it is generally strongly influenced by the diet [15], in the present study has resulted in large differences between groups who were fed in the same way. As for the n6 set, the most abundant fatty acid is arachidonic (C20:4n-6), and more is expressed in FR. However, its function is quite controversial. In fact, although positive during fetal development as a precursor for eicosanoids, later on its effects are detrimental due to high thrombogenic activity [16].

Table 3. Fatty acids content of meat

% tot	CH	MM	FR	Media	Dev. st.
C14:0	2.63[a]	2.90[a]	1.99[b]	2.51	0.753
C16:0	26.92	27.97	28.44	27.76	2.86
C16:1	2.36[b]	3.40[a]	2.31[b]	2.70	1.039
C18:0	20.73[a]	16.41[b]	19.48[c]	18.86	3.308
C18:1	31.41[b]	36.37[a]	32.43[b]	3.43	3.697
C18:2	10.43[a]	7.81[b]	9.03[ab]	9.09	3.686
C18:3 n3	0.83[a]	0.64[b]	0.67[b]	0.72	0.235
C18:3 n6	0.07	0.06	0.06	0.06	0.047
C20:1	0.09[b]	0.13[a]	0.13[a]	0.12	0.026
CLA	0.30[a]	0.25[ab]	0.22[b]	0.26	0.118
C20:3 n6	0.53[b]	0.45[b]	0.74[a]	0.57	0.299
C20:4 n6	2.54[ab]	2.29[b]	3.26[a]	2.7	1.461
C20:5n3 EPA	0.20	0.26	0.23	0.23	0.117
C22:4 n6	0.28	0.28	0.33	0.3	0.179
C22:5 n3 DPA	0.53	0.63	0.51	0.59	0.292
C22:6n3 DHA	0.06	0.08	0.10	0.079	0.133

Table 4. Total fatty acid composition of meat

	SFA %	MUFA %	PUFA %	CLA %	n-6	n-3	n-6/n-3
CH	50.37[a]	33.87[b]	15.76	0.30[a]	13.85	1.62	9.04[a]
MM	47.36[b]	39.90[a]	12.74	0.25[ab]	10.88	1.61	7.00[b]
FR	49.98[a]	34.87[b]	15.15	0.22[b]	13.42	1.51	8.86[a]
Mean	49.22	36.25	14.54	0.26	12.7	1.58	8.28
S.D.	2.967	4.124	5.81	0.118	5.483	0.548	2.171

Table 4 reports the mean values of the main fatty acid categories that were taken into account. Meat from Maremmana cattle has a lower percentage of SFA and a higher percentage of MUFA (+ 5.5 % in average respect to the other two breeds) [17]. PUFA were not different among groups, while the n6/n3 ratio, although very high due to the feed composition with a high content of and barley and corn grains, maize silage, was lower in Maremmana (approximately 2%). It is well known that a lower n6/n3 ratio corresponds to a higher nutritional quality of meat [18], and the recommended value is lower than 4, in order to reduce cancer and heart attacks [19]. Chianina showed the best PUFA/SFA ratio, as it was closest to the threshold of 0.4 that is the recommended value [20].

IV. CONCLUSION

Breed effect clearly emerges from analysis of fatty acids composition of meat. From a nutritional point of view, Maremmana meat resulted low in fat content and was richer in MUFA. This confirms its importance in the frame of Italian beef breeds and certainly justifies its use in this sense. In our study Chianina confirmed its strong meat production aptitude, showing high lean meat yield and a good PUFA/SFA ratio. Lastly, in Holstein, precocity probably had a negative influence on nutritional meat traits due to a higher fat deposition.

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