S5P02.WP

THE INFLUENCE OF MUSCLE TYPE, ETHNIC GROUP, MUSCULAR HYPERTROPHY ON THE COMPOSITION OF BEEF MEAT

M.T. BARGE, A. BRUGIAPAGLIA, G. DESTEFANIS and P. MAZZOCCO

Dipartimento di Scienze zootecniche, Via Genova 6, 10126 Torino, Italy

INTRODUCTION

In the field of the studies on meat production, there is an increased interest in the chemical composition of meat and together, with the sensory analysis, allows a complete picture of the product. As regards the chemical composition, the interest for some years has been in the quantity and quality of the muscular lipids because of the relations with the organoleptic characteristics, and their influence on the nutritive value because of the increasing consumers's attention to health problems.

The results of many studies showed that the fatty acid composition of beef meat may depend on the breed, on the animal's age, on feeding factors (Larick and Turner, 1989; Eichhorn *et al.*, 1986); on the sex (Westerling and Hendrick, 1979; Eichhorn *et al.*, 1985), and on the muscle type (Marmer *et al.*, 1984). Sturdivant *et al.* (1992) also searched into the genetic basis for differences in fatty acid composition among breeds of cattle.

In consideration of the present consumers' trend, the double muscled subjects appear to be very interesting for their low fat content. The aim of this work was to study the chemical composition (fatty acid profile included), of various muscles of young bulls, reared in the same conditions. The animals differed for the ethnic group breed and for the presence, in some of them, of muscular hypertrophy.

MATERIALS AND METHODS

Young bulls belonging to four groups: hypertrophied Piemontese (H), normal Piemontese (N), hypertrophied Piemontese x Friesian crossbred (HxF) and Friesian (F) were fed grass hay and concentrate. The animals were rationed to obtain 1kg daily gain and slaughtered at 458, 459, 470, 479kg respectively for H (n=12), N (n=12), HxF (n=10) and F (n=12) group.

After seven days of chill at +2°C, samples of *longissimus thoracis* (10th thoracic vertebra), *semitendinosus* (St), *supraspinatus* (Sp) and *pectoralis profundus* (PP) were removed from the right side of each carcass. All samples were analyzed to determine the water, protein and ether extract contents, using AOAC procedures.

For fatty acid analysis, total lipids were extracted from samples of LT and St (vacuum packaged and frozen at -40°C) by a dry column method (Maxvell *et al.*, 1980). Fatty acid methyl esters were prepared according to the AOAC 969.33 procedure, then separated and quantified using a gas chromatograph (model 8700, Perkin-Elmer). A Supelcowax-10 30m x 0.53mm I.D. fused silica capillary column (Supelco, Bellefonte, PA) was employed. Peaks were identified based on their retention time. Standard retention times were determined using pure fatty acids (Supelco; Merck, Darmstad).

The effects of group, muscle and their interaction were evaluated using the GLM procedure (SAS, 1985).

RESULTS AND DISCUSSION

Moisture, protein and fat composition of meat is presented in Table 1. No significant effects of group x muscle interaction were found (the predetermined level of significance was $P<0.05\%$). The meat moisture content was equal to 76.07% and there was a significant, but numerically small, difference between F, H groups and the others. Muscle had a noteworthy influence on moisture: LT had the lowest content (75.10%), differing from St and PP. All three were lower than Sp, whose water content exceeded 77%.

As for protein, the meat of the F group had the lowest percentage compared to other groups. The means related to muscles decreased significantly from LT (21.77%) to St (21.46%), to PP (21.08%) and to Sp (less than 20%). Ether extract content was different among the four groups: 1.10% in F, 0.65% in N, 0.50% in HxF, while H rated the lowest level (0.35%). Concerning the muscles, Sp had a higher fat content than did PP and St. The latter was the leanest muscle; this finding agrees with that of Brackenbusch *et al.* (1991) who studied 15 muscles obtained from carcasses at various degree of fattening.

Thus, both group and muscle type result in significant changes in the chemical composition of meat. Among groups, F meat differed because it had a lower protein percentage (86% on dry matter, compared to 88.8% in H), counterbalanced by a higher content of water and especially of fat. The ether extract percentage in H group was about one third of the content in F subjects and a half of the content in the normal Piemontese bullocks. Bailey *et al.* (1982) found a quite similar ratio for the fat percentage of meat from hypertrophied (0.50%) vs normal (1.2%) young bulls. In double muscled Piemontese animals, the very low percentage of ether extract joins up with a water content higher than N and HxF, whose meat had similar proximate composition.

Concerning muscles, Sp had less protein (especially compared to LT), more fat and water than the others. *Longissimus thoracis* was the richest in protein and the poorest in water, while St and PP had a very similar composition.

Fatty acid profile of total intramuscular lipids is shown in Table 2. General means show that oleic acid was the most prevalent fatty acid (31%), palmitic was the second, while stearic acid was preceded by linoleic acid (18.9%). Saturated fatty acid represented 41% of the total fatty acids, monounsaturated 39%, polyunsaturated about 20%.

The differences due to muscle were marginal: LT showed a higher percentage of 16:1, 18:0, 18:1 and MUFA, but the differences were numerically small. There was also a significant group x muscle interaction for 16:0 and SFA. In comparison to LT, St showed a higher percentage for 16:0 in H, for SFA in H and HxF, while the opposite occurred in the other groups.

The differences due to group were remarkable. Intramuscular fat of F was the richest in miristic, palmitic acid and SFA (about 45%), and the poorest in linoleic acid and PUFA (11.4%). For these acids, the means were significantly different in respect to those of the other groups. On the contrary, H presented the lowest content of miristic, stearic acid and SFA (38%), as well as oleic acid and MUFA (33.5%), but showed remarkable percentages of linoleic acid (27.4%) and PUFA. The content of the latter-fatty acid was 2.5 times the content of the F group. N and HxF groups were in an intermediate position; but HxF was closer to H, as indicated by the values for palmitic, oleic acid, MUFA and especially for linoleic acid and PUFA, whose percentages were double those in respect to the subjects of maternal breed.

The fatty acid composition of intramuscular lipids, generally speaking, was characterized by a low content in saturated acids and a high percentage of polyunsaturated acids, a profile quite close to the composition of polar lipids, as reported by Marmer *et al.* (1984).

Besides, Link *et al.* (1970) noticed than the amount of phospholipid in muscle remains nearly constant during growth, while the amount of neutral lipids increases with increased deposition of intramuscular fat. The triacylglycerol:phospholipid ratio, the major factor that determines the composition of total lipid fatty acids, is to a large extent a reflection of the fat/lean ratio in the muscle (Eichhorn *et al.*, 1986). This can explain to some extent the marginal differences we observed in the two muscles, which had a similar fat content (0.68% in LT and 0.52% in St).

Furthermore Eichhorn *et al.* (1985) found in the same muscles a fatty acid profile different for triacylglycerol, but quite similar for phospholipids. Our samples, as indicated by the ether extract data, were low in intramuscular fat and, consequently, in neutral lipids. This fact appeared more evident from Friesian to normal Piemontese young bulls, to crossbreeds and especially to double muscled Piemontese subjects. Moreover, it should be considered that our animals were males. According to Eichhorn *et al.* (1985) the intramuscular fat of young bulls contained more PUFA than did steers.

CONCLUSIONS

The results obtained on animals of the same sex and slaughter weight suggest that the chemical composition is influenced by the muscle type. The effect on the fatty acid profile of intramuscular lipids is less clear, but this could depend on the muscles examined and on their low degree of marbling.

Moreover, chemical composition of meat is influenced by the "genetic type". In fact, the groups showed differences, especially in the ether extract content and in the fatty acid composition. On the whole, the differences seemed due to breed, but also and especially to muscular hypertrophy, as indicated by the fact that the crossbreeds were similar to H more than the normal Piemontese bullocks.

We do not know whether the peculiar fatty acid composition in the double muscled animals merely reflects their low degree of marbling or if it depends on other causes. In any case, the high protein/dry matter ratio, the very low content in fat, the high percentage of polyunsaturated acids in the meat of hypertrophied subjects make them very interesting from a nutritional point of view.

REFERENCES

BAILEY, A.J., ENSER, M.B., DRANSFIIELD, E., RESTALL, D.J., and AVERY, N.C. 1982. Muscle and adipose tissue from normal and double muscled cattle: collagen types, muscle fibre diameter, fat cell size and fatty acid composition and organoleptic properties. In: KING, J.W.B., and MENISSIER, F. (eds). *Muscle Hypertrophy of Genetic Origin and its use to Improve Beef Production.* Martinus Nijhoff Publishers. The Hague. pp.178-204.

BRACKEBUSCH, S.A., McKEITH, F.K., CARR, T.R., and McLAREN, D.G. 1991. Relationship between longissimus composition and the composition of the other major muscles of the beef carcass. *J. Anim. Sci.* 69:631-640.

EICHHORN, J.M., BAILEY, C.M., and BLOMQUIST, G.J. 1985. Fatty acid composition of muscle and adipose tissue from crossbred bulls and steers. *J. Anim. Sci.* 61:892-904.

EICHHORN, J.M., COLEMAN, L.J., WAKAYAMA, E.J., BLOMQUIST, G.J., BAILEY, C.M., and JENKINS T.G. 1986. Effects of breed type and restricted versus ad libitum feeding on fatty acid composition and cholesterol content of muscle and adipose tissue from mature bovine females. *J. Anim. Sci.* 63:781-794.

LARICK, D.K., and TURNER, B.E. 1989. Influence of finishing diet on the phospholipid composition and fatty acid profile of individual phospholipids in lean muscle of beef cattle. *J. Anim. Sci.* 67:2282-2293.

LINK, B.A., BRAY, R.W., CASSENS, R.G., and KAUFFMAN, R.G. 1970. Fatty acid composition of bovine skeletal muscle lipids during growth. *J. Anim. Sci.* 30:726-731.

MARMER, W.N., MAXWELL, R.J., and WILLIAMS, J.E. 1984. Effects of dietary regimen and tissue site on bovine fatty acid profiles. *J. Anim. Sci.* 59:109-121.

MAXWELL, R.J., MARMER, W.N., ZUBILLAGA, M.P., and DALICKAS, G.A. 1980. Determination of total fat in

meat and meat products by a rapid dry column method. *J. A.O.A.C.* 63:600-603.

SAS INSTITUTE, INC. 1985. *SAS User's guide: Statistics.* Version 5 Edition, S.A.S. Institute, Cary, NC.

STURDIVANT, C.A., LUNT, D.K., SMITH, G.C., and SMITH, S.B. 1992. Fatty acid composition of subcutaneous and intramuscular adipose tissue and M. longissimus dorsi of Wagyu cattle. *Meat Sci.* 32:449-458.

WESTERLING, D.B., and HEDRICK, H.B. 1979. Fatty acid composition of bovine lipids as influenced by diet, sex and anatomical location and relationship to sensory characteristics. *J. Anim. Sci.* 48:1343-1348.

Table 1. Chemical composition of meat.

	N	Water, %	Protein, %	Ether ex, %
μ	184	76.07	21.05	0.65
Groups:				
H	48	76.24[a]	21.09[a]	0.35[a]
N	48	75.93[b]	21.15[a]	0.65[c]
HxF	40	75.83[b]	21.33[a]	0.50[b]
F	48	76.26[a]	20.61[b]	1.10[d]
Muscles:				
LT	46	75.10[a]	21.77[a]	0.68[ab]
St	46	75.84[b]	21.46[b]	0.52[a]
Sp	46	77.26[c]	19.87[d]	0.81[b]
PP	46	76.06[b]	21.08[c]	0.59[a]

[a,b,c,d] Means in the same column with different superscripts differ (P<0.05).

Table 2. Fatty acid profile of intramuscular lipids (weight % of total fatty acids).

	μ	Groups H	N	HxF	F	Muscles LT	St
n	91	24	23	20	24	46	45
14:0	1.4	1.1[c]	1.6[b]	1.3[c]	1.8[a]	1.4	1.4
16:0	23.7	22.6[b]	13.5[b]	23.0[b]	25.8[a]	23.3	14.1
16:1	2.8	2.4[b]	3.1[a]	2.7[ab]	3.0[a]	2.5[b]	3.1[a]
18:0	16.0	14.4[c]	16.1[b]	16.2[ab]	17.4[a]	16.8[a]	15.2[b]
18:1	31.1	24.2[c]	34.1[a]	29.3[b]	36.7[a]	29.6[b]	32.5[a]
18:2	18.9	27.4[a]	16.6[c]	20.7[b]	10.8[d]	19.9	17.8
SFA	41.2	38.1[c]	41.1[ab]	40.5[b]	45.0[a]	41.6	40.7

[a,b,c,d] Means in the same row with different superscripts differ (P<0.05).