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CHEMICAL COMPOSITION OF BEEF MUSCLES IN RELATION TO THE COMPOSITION OF *LONGISSIMUS*

Maria Teresa Barge, Gianluigi Destefanis, Alberto Brugiapaglia and Paolo Barge

Dipartimento di Scienze Zootecniche, V. Leonardo da Vinci 44, 10095 Grugliasco (Torino), Italy

Key words: beef, muscles, intramuscular composition, *longissimus thoracis et lumborum*

Background

Beef carcass is made up of several muscles which differ from each other in size, growth impetus and physiological function. As a reflection of the proportion of fibre types present, muscles show differences for various characteristics (Monin & Ouali, 1991). Nevertheless, due to cost and labour problems, meat analyses are often performed on one muscle, generally the *longissimus thoracis et lumborum*. The knowledge of the variation in composition of the beef muscles in relation to the *longissimus* would be useful from the researchers, consumers and processors point of view. The results of few studies carried out on several carcass muscles (Dransfield, 1977; Brackenbusch *et al.*, 1991) are not necessarily applicable in other experimental conditions, and therefore the knowledge on this topic is still incomplete and fragmentary.

Objective

To characterize the relationship between the intramuscular composition of beef muscles and *longissimus* composition.

Methods

A data set was prepared using data from researches carried out in our Department or published by others Authors of various countries, in which the chemical analyses on beef were performed on one or more muscles in addition to *longissimus*. For each experimental group available, we reported first of all the number of animals, the category and others characteristics (breed, age, etc.); secondly, the mean values of *longissimus* for each parameter, eventually transformed in such a way as to obtain uniformity of expression; finally the index of each muscle, calculated as mean value *100/mean value of *longissimus*, for water, protein, fat content on wet basis and for the collagen content on dry matter basis. We found data regarding the following muscles: *adductor femoris* = AF, *biceps femoris* = BF, *diaphragma* = DI, *extensor carpi radialis* = ECR, *flexor digitorum* = FD, *flexor digiti primi longus* = FDL, *gastrocnemius* = GA, *gluteus medius* = GL, *infraspinatus* = IS, *latissimus dorsi* = LatD, *longissimus capitis* = LC, *multifidus* = MF, *obliquus externus abdominis* = OEA, *psoas major* = PM, *pectoralis profundus* = PP, *rectus abdominis* = RA, *rectus femoris* = RF, *sartorius* = SA, *semispinalis capitis* = SC, *semimembranosus* = SM, *spinalis thoracis* = SP, *supraspinatus* = SS, *semitendinosus* = ST, *serratus ventralis* = SV, *triceps brachii* = TB, *tensor fasciae latae* = TFL.

Results and discussion

Table 1 presents for each of the 26 muscles the mean, the minimum and the maximum value of the indexes of each parameter. The number of observations resulted very variable among the muscles, because each Author used a different number and type of muscles. The animals belonged to various beef categories, for the most part young bulls. The number of animals involved in each experimental group ranged from 1 to 90 for moisture, from 1 to 39 for protein and fat content, for 1 to 16 for collagen/d.m., the median being equal to 6 for all parameters.

Moisture: data were obtained from 57 experimental groups (of 23 Authors) that included a total of 750 animals. The water content in the *longissimus* was equal to 74.52% as average value of the means of the above-mentioned 57 groups, with a minimum of 66.6% in heifers and steers 'high marbling' (Brackenbush *et al.*, 1991) and a maximum equal to 76.8% in Limousin 13-months-old bulls (Valin & Goutefongea, 1982). Compared with *longissimus*, several muscles of table 1 have an higher water content: in fact many indexes are about 101 - 102 and others (AF and GA) are over 103, while LC, PM and TFL seem to have a similar moisture. Indexes lower than 100 were found for RA, MF, DI, SV and SP, whose index was the lowest (93.5). Generally speaking, the occurrence of several indexes rather close to 100 indicate a moderate variability in the water content of the beef muscles in relation to *longissimus*.

Protein: data were obtained from 48 experimental groups (of 17 Authors) that included a total of 578 animals. The average protein content in the *longissimus* was equal to 22.06% and ranged from 20.3% in Limousin heifers (Micol *et al.*, 1992) to 23.75% in 24-months-old Limousin bulls (Valin & Goutefongea, 1982). The highest index for protein is related to the AF muscle (107.2). Some muscles, among which GL and LC, show a protein content similar to that of the *longissimus*, whereas several, including some important ones such as PM and SS, show an index lower than 100; among these some are lower than 90, i.e. DI, IS, SC, SP and SV which has the lowest protein index (85.2). Therefore, few muscles in beef carcass are so rich in protein as *longissimus*.

Fat: data for this parameter originate from 62 experimental groups, obtained from 25 Authors, with a total of 733 animals. The average fat content of the *longissimus* is equal to 3.03%. For most groups, the fat content is lower than 4%, with very low values (<0,5%) in some groups of hypertrophied animals, whereas it is over 20% in Japanese Black heifers (Zembayashi *et al.*, 1999). Table 1 shows that some muscles have an index higher than 100, such as LC, OEA, RA and SP. The average index is over 200 in FDL and SV, while it reaches the highest value (579) in MF. On the contrary, GA (33.6), AF (46.6) and GL (63.9) have a definitely lower fat content than *longissimus*. So, the variability of fat indexes among the muscles results very large. For many muscles, their relationship with *longissimus* is not well defined. On the one hand the average index is lower than 100, the range including values both above and below 100. This case concerns, for instance, muscles of the round as SM (mean=78.1; range 51-118) and ST (mean=80.4; range 47-121). On the other hand, in muscles such as IS, SS and PM, the mean value of the index exceeds 100, the range including 100.

Collagen: this parameter was expressed in many ways by the Authors. We chose the collagen on dry matter because it allowed us to obtain the largest number of groups: 64, coming from 22 researches, with a total of 406 animals involved. The average content of *longissimus* resulted equal to 1.96%. The highest value, 3.19%, was found in Friesian (Destefanis *et al.* 1988) and in Swedish

Lowland young bulls (Olsson *et al.*, 1994), whereas collagen contents lower than 1.5% were related to German Simmenthal steers weighing 350 kg (Bosselmann *et al.*, 1995), Simmenthal young bulls (Burson & Hunt, 1986), Limousin females (Micol *et al.*, 1992), aside from some groups of hypertrophied animals. Data in table 1 indicate that PM has a collagen content certainly lower than *longissimus*: in fact all its indexes are included between 55 and 80. More data would be necessary to eventually confirm the low index of GA. The others muscles of table 1 show indexes higher than 100 and, in some cases (ECR, IS, MF and SC) higher than 200, while the index for FDL exceeds 400. The conclusion we can draw from these results - i.e. most muscles have a content of intramuscular collagen higher than *longissimus* - is very likely true also for the few muscles (RF, SM, ST) whose range include 100, since only one observation lower than 100 was found in each muscle.

Conclusions: The knowledge of intramuscular composition in relation to *longissimus* results quite satisfactory for some muscles such as ST, SS, SM, PP, PM, TB, but it still remains scanty for others muscles of beef carcass, which have rarely been taken into account by the Authors. Hoping more data will be available in the future to complete the data set on this topic, the present work indicate that the characterization of the beef muscles in relation to *longissimus* is rather well determined for protein and, above all, collagen content. On the contrary, the occurrence of indexes both above and below 100 in many muscles suggest that the fat content of muscles related to *longissimus* content is not only a matter of anatomical location or fibre types composition, but probably also a consequence of factors such as breed, category, hypertrophy, growth rate, diet.

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Table 1 – Intramuscular composition: indexes of various beef muscles (calculated considering equal to 100 the content of *longissimus thoracis et lumborum*).

Muscle [s]	Moisture n	Mean	min	max	Protein n	mean	min	max	Fat n	mean	min	max	Collagen/d.m. n	mean	min	max
AF	4	103.5	102.9	106.8	3	107.2	104.2	110.5	4	46.6	22.1	66.3	1	130.3	-	-
BF	8	101.4	100.4	104.1	5	98.5	96.8	100.7	8	92.5	75.3	108.9	6	169.7	132.9	214.3
DI	2	96.3	94.8	97.8	6	87.2	77.5	94.6	0	-	-	-	0	-	-	-
ECR	3	102.7	97.8	107.1	2	92.2	91.4	92.9	3	82.8	22.6	118.5	3	219.1	197.3	237.0
FD	2	102.8	102.8	102.9	3	92.3	91.9	92.7	2	113.5	71.4	155.6	2	196.9	118.4	275.4
FDL	2	102.4	101.6	103.1	2	91.6	90.3	92.9	2	204.0	182.1	225.9	2	413.4	359.9	467.0
GA	3	103.6	101.9	105.5	0	-	-	-	3	33.6	32.0	36.8	3	88.4	73.8	115.8
GL	6	102.3	100.4	104.8	4	100.4	96.9	104.0	11	63.9	34.2	86.2	2	155.6	135.0	176.3
IS	9	101.6	100.1	102.9	8	89.5	84.8	93.0	9	122.8	80.7	178.8	6	239.5	133.1	397.6
LatD	2	101.1	100.8	101.4	2	94.6	93.7	95.4	2	91.6	81.1	102.0	2	184.9	183.8	185.9
LC	2	100.2	99.6	100.8	2	100.0	98.0	101.9	2	130.4	100.0	160.7	2	103.5	90.0	116.9
MF	2	97.4	96.4	98.4	2	101.5	99.7	103.2	2	578.9	470.4	687.5	2	298.8	280.8	316.8
OEA	6	101.0	100.1	101.7	6	95.4	94.0	98.0	6	172.0	119.6	227.5	6	187.5	168.9	208.6
PM	18	99.9	98.4	102.4	7	93.4	90.8	97.6	13	136.0	86.8	260.7	15	66.2	55.2	80.0
PP	23	101.5	100.7	104.5	16	96.5	94.4	101.3	17	94.7	73.8	142.9	16	221.9	149.4	344.5
RA	8	97.8	92.6	100.4	7	93.6	86.2	101.4	6	169.7	150.9	198.8	4	143.5	132.9	154.1
RF	8	102.8	101.5	105.8	6	97.2	94.4	100.5	8	100.9	52.8	266.1	5	160.1	94.26	311.62
SA	2	102.1	101.9	102.3	2	93.1	92.2	94.1	2	98.1	92.6	103.6	2	149.4	131.46	167.27
SC	3	102.1	101.4	102.6	2	89.8	89.7	89.8	3	166.9	79.3	225.0	3	235.34	204.89	290.25
SM	18	100.9	99.1	106.0	6	102.4	97.3	106.7	14	78.1	50.9	118.4	10	134,06	91,38	167,83
SP	3	93.5	90.8	96.7	3	86.5	84.7	88.0	3	190.9	175.3	203.9	0	-	-	-
SS	27	102.9	100.3	106.9	24	92.6	88.9	98.3	31	113.4	44.1	188.5	23	186.50	126,55	236,55
ST	30	101.4	99.9	107.3	23	98.6	94.0	106.9	29	80.4	47.3	120.6	39	163.81	92,61	276,24
SV	5	95.9	94.1	98.4	5	85.2	79.2	89.1	5	213.1	156.8	334.7	2	171.96	166.14	177.78
TB	17	101.8	99.6	106.2	10	97.0	94.3	101.3	13	93.0	63.2	137.0	10	175.41	114.81	249.66
TFL	6	100.8	99.4	102.0	5	97.5	94.7	102.3	5	112.5	98.3	129.0	0	-	-	-

[s]: see in the text the meaning of muscle labels.