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Original article

Distribution of tissues in carcasses at the same proportion of total fat in Portuguese cattle breeds

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Abstract — A comparison was made of the distribution of bone, muscle, subcutaneous fat and intermuscular fat (g of tissue in the joint per kg of the respective tissue in the carcass) at the same proportion of total carcass fat for a total of 165 animals from three large (Alentejana (n = 24); Mirandesa (n = 24); Marinhoa (n = 24)), and four small, (Arouquesa (n = 24); Barrosã (n = 23); Maronesa (n = 24) and Mertolenga (n = 22)) Portuguese breeds, serially slaughtered at three different weights. The distribution of muscle was significantly different across breeds in a larger number of joints than either the distribution of bone, subcutaneous fat or intermuscular fat. However, the range of differences in each joint was narrower for muscle. So, amongst the first class joints (leg, sirloin, ribs and fore ribs), only the sirloin and the fore ribs, both with a range across breeds of only 7 $g \cdot kg^{-1}$, were significantly different between breeds. On the contrary to subcutaneous fat, the proportions of intermuscular fat tend to decrease, particularly in the leg. As expected, the joints with homogeneous parameters were the most accurate for predicting the proportion of muscle ($g \cdot kg^{-1}$) in the carcass from the proportion of muscle ($g \cdot kg^{-1}$) in the joint. For the large breeds, the most accurate joints were the leg and the coast, with a residual s.d. of 13.91 $g \cdot kg^{-1}$ and 18.45 $g \cdot kg^{-1}$, respectively; and for the small breeds the most accurate joints were the fore ribs and the leg, with a residual s.d. of 15.35 $g \cdot kg^{-1}$ and 17.11 $g \cdot kg^{-1}$, respectively. The difference between the actual breed means and the means predicted using the overall equation for each of the most accurate joints were lower than ± 4 $g \cdot kg^{-1}$ for all breeds with the exception of the Barrosã with a value of –8 $g \cdot kg^{-1}$.

distribution / joints / carcasses / beef cattle

Résumé — Répartition des tissus dans les carcasses de bovins de races autochtones portugaises. Une étude comparative a été menée sur la répartition des tissus osseux, musculaires, adipeux sous-cutané et adipeux intermusculaires (g de tissu dans le morceau par kg de tissu respectif dans la carcasse) pour une même proportion de gras total. Au total 165 animaux, comprenant des races de grande taille : Alentejana (n = 24), Mirandesa (n = 24), Marinhoa (n = 24), et des races de petite taille :

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Arouquesa (n = 24), Barrosã (n = 23), Maronesa (n = 24) et Mertolenga (n = 23), ont été séquentiellement abattus à 3 poids différents. Le muscle était le tissu dont la répartition a été significativement différente entre les morceaux, mais où l'amplitude des différences entre races, pour chaque morceau, a été plus étroite. Parmi les morceaux de première catégorie, seuls l'aloyau et l'entrecôte, tous deux avec une amplitude de 7 $g \cdot kg^{-1}$, ont été significativement différents entre les races. Comme attendu, les morceaux avec des paramètres de régression homogènes ont été les plus précis pour prédire la proportion de muscle ($g \cdot kg^{-1}$) dans la carcasse à partir de la proportion de muscle ($g \cdot kg^{-1}$) dans le morceau. Pour les races de grande taille, ces morceaux ont été le globe et la poitrine, avec un écart type résiduel de 13,91 et 18,45 $g \cdot kg^{-1}$, respectivement. Pour les races de petite taille, les morceaux ont été l'entrecôte et le globe, avec un écart type résiduel de 15,35 et 17,11 $g \cdot kg^{-1}$, respectivement. La différence entre les moyennes réelles de la race et les moyennes prédites, en utilisant l'équation globale pour les morceaux les plus pertinents, a été inférieure à $\pm$ 4 $g \cdot kg^{-1}$ pour toutes les races, à l'exception de la Barrosã, avec une valeur de –8 $g \cdot kg^{-1}$.

répartition / morceaux / carcasses / taurillons

1. INTRODUCTION

In Portugal there are 13 registered native cattle breeds, with a total of 74 500 females recorded in the herd books. The most important breeds are Mertolenga (ME) accounting for 19% of the total, Alentejana (AL), Barrosã (BA), and Maronesa (MA) accounting for 10% each, Mirandesa (MI) and Arouquesa (AR) accounting for 8% each, and Marinhoa (MO) accounting for 6% [8]. Both AL and ME are widely spread in the flat lands of the South, which represents one third of the total area of the country. These two breeds are usually crossed with beef bulls, mainly Charolais and Simmental.

The present EU policy in support of sustainable agriculture with a repercussion on the social, regional and environmental equilibrium has generated new interest in native cattle breeds. Accordingly, within PAMAF (a National programme for the support of modernisation of agriculture and forestry), a project was organised to study the growth, carcass composition, distribution of tissues and meat quality of the native cattle breeds. Some of the findings on carcass composition were published previously by Simões and Mira [21].

The objective of the present work was to study the effect of the breed on the distribution of bone, muscle, subcutaneous fat and intermuscular fat in joints in relation to the distribution of the corresponding tissues in the carcass. In addition, the effect of breed on the homogeneity of the parameters (slope and intercept) and on the accuracy of regression equations for predicting the proportions of muscle in the side from the respective proportions in the joint was also examined.

2. MATERIALS AND METHODS

2.1. Animals

The breeds represented in the study were the Portuguese large sized (Alentejana (AL), Mirandesa (MI), and Marinhoa (MO)), and the small sized (Arouquesa (AR), Barrosã (BA), Maronesa (MA) and Mertolenga (ME)) breeds. Each breed was represented by 24 animals (Tab. I).

At weaning (6 months of age), and with a range of sizes representing the standard for the breeds, the male calves were delivered by the respective breed associations to the feed-lot facilities at EZN (National Zootechnical Station). After an adaptation period, they were allocated to the three target slaughter weights. These were 400, 525 and 650 kg for the large breeds and 300,

Table I. Range of carcass weight and concentration (g·kg^{-1}) of bone, muscle and total fat (subcutaneous fat, intermuscular fat and kidney knob channel fat) in the carcass.

Breeds	No	Range	Bone (g·kg^{-1})		Muscle (g·kg^{-1})		Total fat (g·kg^{-1})	
			Mean	SD	Mean	SD	Mean	SD
Large								
AL	24	155–460	173.06	18.50	672.65	32.29	154.29	36.24
MI	24	160–466	170.96	17.84	677.53	29.61	151.50	35.29
MO	24	166–508	174.32	14.25	695.25	18.31	130.43	20.17
Small								
AR	24	112–322	173.81	17.68	682.57	30.76	143.62	41.37
BA	23	103–336	169.89	19.59	670.15	35.02	159.96	48.95
MA	24	97–350	169.58	24.82	682.43	28.03	147.98	41.49
ME	22	115–342	154.33	12.84	700.31	20.51	145.36	19.74

AL: Alentejana; MI: Mirandesa; MO: Marinhoa; AR: Arouquesa; BA: Barrosã; MA: Maronesa; ME: Mertolenga.

425 and 550 kg for the small breeds with 8 animals per slaughter group. The 24 animals of each breed were blocked on weight before distribution to these slaughter groups, so the mean initial body weight of the groups was similar. A diet of maize silage supplemented with a concentrate of maize, barley and sunflower cake was offered ad libitum. The metabolisable energy (ME) concentration of the total diet was 11.7 MJ·kg^{-1} dry matter and the crude protein concentration was 122 g·kg^{-1}.

2.2. Carcass dissection

The hot carcasses were split along the column, and after 24 hours at 6 ºC they were aged at 2 ºC for 1 week. The kidney knob and channel fat (KKCF) was removed from both sides and weighed. Alternatively, the right or left side of each carcass was divided into the traditional Portuguese cuts which in the present study were then grouped into the following main joints: hind shin, leg, sirloin, thin flank, ribs, middle coast, coast, fore ribs, shoulder, fore shin and neck (Fig. 1).

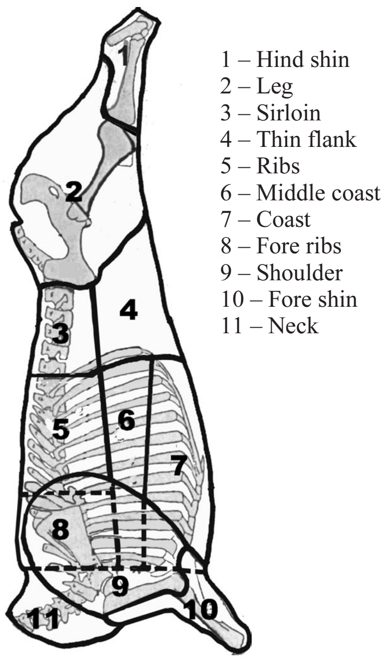

Figure 1. Side of beef showing commercial joints.

Each joint was dissected into the bone, muscle, subcutaneous fat, intermuscular fat and residue. The total weight of these dissected tissues, plus half the weight of KKCF in the side was used as the denominator for calculating the proportions.

The number of carcasses, range of carcass weight and proportion of bone, muscle and total carcass fat (subcutaneous fat, intermuscular fat and KKCF) per breed are given in Table I.

2.3. Statistical analysis

The analysis of variance with regression were done following the models described by Freund et al. [9] and carried out using SAS [19].

Concerning the distribution of the tissues, the effect of breed on bone, muscle, subcutaneous fat and intermuscular fat proportion in the joint were analysed using the total fat proportion as a covariate. The within breed regression coefficients were tested for homogeneity following the model:

$$Y_{ij} = \mu + B_i + b\, X_j + b_i\, X_{ij} + e_{ij}$$

where Y_{ij} is the bone, muscle, subcutaneous fat and intermuscular fat proportion in the joint in relation to the respective tissue in the carcass on the jth animal belonging to the ith breed; μ is the overall mean; B_i is the fixed effect of the ith breed; b is the overall regression coefficient of Y_{ij} on the total fat proportion (X_j) , of the jth animal; b_i is the regression coefficient of Y_{ij} on the total fat proportion (X_{ij}) of the jth animal of the ith breed; and e_{ij} is the random error, N (0, σ).

Whenever the breed regression was found to be homogeneous, the following model was used to test for fixed effects of breed on bone, muscle, subcutaneous fat and intermuscular fat proportion in a particular joint in relation to the respective tissue in the carcass adjusted to the overall mean of the total fat proportion by the common regression coefficient:

$$\text{Adjusted } (Y_{ij}) = \mu + B_i + b\,(X_j - x) + b_i \times (X_{ij} - x) + e_{ij}$$

in which all variables and parameters have the same meaning and x is the constant value of total fat per kg of carcass weight.

Regarding the prediction of the muscle proportion in the carcass from the proportion of muscles in each joint, a similar procedure was used to test for the homogeneity of the sire breed regression coefficients and intercepts, through adjusted means, separately for large and small breeds.

To test the homogeneity of the sire breed regression the model was as follows:

$$Y_{ij} = \mu + B_i + b\, X_j + b_i\, X_{ij} + e_{ij}$$

where Y_{ij} is the proportion of muscle in the carcass on the jth animal belonging to the ith breed; μ is the overall mean; B_i is the fixed effect of the ith breed; b is the overall regression coefficient of Y_{ij} on the proportion of muscle (X_j) in the joint, of the jth animal; b_i is the regression coefficient of Y_{ij} on the proportion of muscle (X_{ij}) in the joint, of the jth animal of the ith breed; and e_{ij} is the random error, N (0, σ).

The following model was used in order to test the homogeneity of the sire breed intercepts through the adjusted means:

$$\text{Adjusted } (Y_{ij}) = \mu + B_i + b\,(X_j - x) + b_i \times (X_{ij} - x) + e_{ij}$$

in which all variables and parameters have the same meaning and x is the constant value of the total muscle proportion in the carcass.

3. RESULTS AND DISCUSSION

The adjusted means, and the regression coefficients on the proportion of total fat, for the distribution of bone in each joint are shown in Table II. There were significant,

Table II. Distribution of bone (g of bone in the joint per kg of bone in the carcass) at 152 g total carcass fat per kg carcass weight, standard error of means (SE), F-test for the means, and regression coefficients for the proportion of bone ($g \cdot kg^{-1}$) in the joint to the proportion of total carcass fat ($g \cdot kg^{-1}$).

	Hind shin	Leg	Sirloin	Thin flank	Ribs	Middle coast	Coast	Fore ribs	Shoulder	Fore shin	Neck
Breed											
AL	109	218	65	6	82	51	147	60	47	156	59
AR	113	226	65	7	81	49	141	61	47	148	62
BA	119	228	66	5	79	49	136	61	46	152	59
MA	113	223	62	8	80	49	146	63	47	148	61
ME	112	222	64	6	84	50	144	58	47	153	61
MI	110	225	66	6	85	52	145	62	47	146	57
MO	109	229	69	6	83	52	131	67	47	146	61
Standard error of means (SE)	2.40	2.05	1.60	0.89	1.70	1.36	3.50	1.59	0.72	1.72	1.70
F-test for the variances	***	**	NS	NS	NS	NS	*	**	NS	***	NS
Regression coefficients	–0.12***	–0.08***	–0.03NS	0.01NS	0.05*	0.05**	0.20***	0.05**	0.03***	–0.16***	0.004NS

For abbreviations, see Table I. ***: $P \leq 0.001$; **: $P \leq 0.01$; *: $P \leq 0.05$.

but relatively small differences between breeds in the adjusted means for the leg, fore ribs and coast. The smallest difference recorded was in the fore ribs, 9 $g \cdot kg^{-1}$, between MO and ME; and the largest difference in the coast, 16 $g \cdot kg^{-1}$, between AL and MO. Berg et al. [3] reported small and biologically unimportant differences between breeds in the distribution of the bone.

The regression coefficients indicate the rate of change in the proportion of side bone in the joints relative to changes in total carcass fat proportion. For the first class joints (leg, sirloin, ribs, fore ribs), the proportion of total bone in the leg decreased as the proportion of carcass fat increased. The proportion of bone remained constant in the sirloin and increased in the fore ribs and ribs.

The distribution of muscle is shown in Table III. There were significant differences between breeds in the hind shin, sirloin, thin flank, fore ribs, shoulder, fore shin and neck. The minimum difference was in the fore shin (4 $g \cdot kg^{-1}$ between ME and MI) and the maximum difference was in the thin flank (9 $g \cdot kg^{-1}$ between AL and MO). These results agree with those from many other studies [1, 2, 6, 7, 11, 13, 14, 16–18] in which the differences between breeds in the proportion of muscle in each joint, even when statistically significant, are commercially unimportant. According to Berg and Butterfield [4, 5] functional demands account for the narrow range of variation in this distribution of muscle.

The greatest differences between breeds are in the proportion of first class joints, when the comparisons amongst breeds, which differ greatly in maturity, were carried out at the same age or weight. The heaviest breeds slaughtered at a small proportion of the respective mature weight maximise the early maturing joints, particularly in the hind quarter [10, 20]. In the present study, the animals were serially slaughtered, taking into account the mature weight of the breeds. Significant differences were not found in the proportion of muscle in the leg or ribs, but there were statistically significant differences in the sirloin and fore ribs. The variation between breeds was small, 7 $g \cdot kg^{-1}$ in any of the last two joints.

With reference to the first class joints, the regression coefficients indicated that, as the proportion of total fat in the side increased, the proportion of muscle in the leg, in relation to the total muscle in the side decreased ($b = -0.29$). This was possibly a direct consequence of a decrease in the proportion of the leg itself, an early maturing joint, as growth proceeds, as occurred with bone. The proportions remained constant in the sirloin and ribs, and increased slightly in the fore ribs ($b = 0.06$).

The results for subcutaneous fat are shown in Table IV. There were significant differences between breeds for the adjusted means in the hind shin, sirloin, middle coast, coast, fore ribs, shoulder and neck. The lowest difference was found in the fore ribs (13 $g \cdot kg^{-1}$ between AR and AL) and the highest difference was found in the neck (44 $g \cdot kg^{-1}$ between BA and MO).

Regarding the higher priced joints, the regression coefficients show that the proportion of subcutaneous fat remained constant in the leg, sirloin and fore ribs, and increased slightly in the ribs. On the contrary, there was a large decrease in the proportion of subcutaneous fat in the neck with increasing total carcass fat.

In contrast to the findings for subcutaneous fat, the proportion of intermuscular fat (Tab. V) tended to decrease, particularly in the leg.

There were significant differences between the breeds in the hind shin, ribs, fore ribs and fore shin for the proportion of intermuscular fat (Tab. V). The smallest difference was found in the hind shin (8 $g \cdot kg^{-1}$ between BA and MO) and the largest was found in the ribs (22 $g \cdot kg^{-1}$ between MI and AR). The results for the distribution of subcutaneous fat and inter-muscular fat

Table III. Distribution of muscle (g of muscle in the joint per kg of muscle in the carcass) at 152 g total carcass fat per kg carcass weight, standard error of means (SE), F-test for the means, and regression coefficients for the proportion of muscle ($g \cdot kg^{-1}$) in the joint to the proportion of total carcass fat ($g \cdot kg^{-1}$).

	Hind shin	Leg	Sirloin	Thin flank	Ribs	Middle coast	Coast	Fore ribs	Shoulder	Fore shin	Neck
Breed											
AL	20	308	80	62	73	56	49	84	98	37	15
AR	24	312	78	54	70	52	48	85	99	38	16
BA	22	325	81	55	71	51	47	80	98	38	15
MA	22	307	77	57	71	51	50	84	100	36	15
ME	21	308	78	61	73	53	51	82	93	34	13
MI	22	313	78	53	71	51	51	83	96	38	14
MO	19	309	74	53	70	54	51	87	96	36	15
Standard error of means (SE)	0.84	4.40	1.05	1.05	0.90	1.39	1.30	1.21	0.85	0.83	4.6
F-test for the variances	**	NS	***	***	NS	NS	NS	*	***	*	*
Regression coefficients	–0.03**	–0.29***	–0.02NS	0.02NS	0.00NS	0.02NS	0.05***	0.06***	0.01NS	–0.04*	–0.01**

For abbreviations, see Table I. ***: $P \leq 0.001$; **: $P \leq 0.01$; *: $P \leq 0.05$.

Table IV. Distribution of subcutaneous fat (g of sub fat in the joint per kg of sub fat in the carcass) at 152 g total carcass fat per kg carcass weight, standard error of means (SE), F-test for the means, and regression coefficients for the proportion of subcutaneous fat ($g \cdot kg^{-1}$) in the joint to the proportion of total carcass fat ($g \cdot kg^{-1}$).

	Hind shin	Leg	Sirloin	Thin flank	Ribs	Middle coast	Coast	Fore ribs	Shoulder	Fore shin	Neck
Breed											
AL	23	299	90	101	95	43	92	32	76	34	112
AR	25	276	70	104	84	52	91	45	91	39	124
BA	26	289	68	109	80	44	107	35	78	36	128
MA	28	276	73	122	87	40	90	37	83	36	126
ME	19	267	69	122	87	74	91	35	93	35	108
MI	32	296	72	101	83	53	77	41	87	39	108
MO	28	271	79	110	94	69	87	42	90	45	84
Standard error of means (SE)	2.20	10.05	3.4	8.70	5.1	7.20	5.60	3.05	4.20	2.70	0.86
F-test for the variances	**	NS	***	NS	NS	**	*	*	*	NS	**
Regression coefficients	–0.07**	–0.00NS	0.03NS	0.28**	0.14**	0.27***	–0.11NS	0.012NS	0.10*	–0.12***	–0.51***

For abbreviations, see Table I. ***: $P \leq 0.001$; **: $P \leq 0.01$; *: $P \leq 0.05$.

Table V. Distribution of intermuscular fat (g of inter fat in the joint per kg of inter fat in the carcass) at 152 g total carcass fat per kg carcass weight, standard error of means (SE), F-test for the means, and regression coefficients for the proportion of intermuscular fat ($g \cdot kg^{-1}$) in the joint to the proportion of total carcass fat ($g \cdot kg^{-1}$).

	Hind shin	Leg	Sirloin	Thin flank	Ribs	Middle coast	Coast	Fore ribs	Shoulder	Fore shin	Neck
Breed											
AL	19	219	23	118	102	93	106	70	56	33	155
AR	15	212	22	115	100	104	117	64	57	29	161
BA	20	221	24	117	101	93	106	61	53	32	170
MA	16	210	24	111	109	101	107	76	57	25	163
ME	15	210	24	123	109	105	115	59	49	25	167
MI	14	218	21	112	122	108	112	58	53	27	160
MO	12	204	19	130	119	105	119	63	50	24	152
Standard error of means (SE)	1.97	6.00	2.40	5.50	4.9	6.40	6.00	4.00	2.30	1.90	7.3
F-test for the variances	*	NS	NS	NS	***	NS	NS	*	NS	**	NS
Regression coefficients	0.12***	–0.71***	–0.11***	0.63***	0.32**	0.28***	0.35***	–0.21***	–0.17***	–0.09***	–0.28***

For abbreviations, see Table I. ***: $P \leq 0.001$; **: $P \leq 0.01$; *: $P \leq 0.05$.

Table VI. Regression parameters for the proportion (g·kg^{-1}) of muscle in the carcass on proportions (g·kg^{-1}) of muscle in the joints: pooled regression coefficients within breeds and average intercepts when homogeneous (not significantly different between breeds) and the overall residual standard deviation (RSD) using a common regression line for each joint.

	Large breeds (AL, MI and MO)			Small breeds (AR, BA, MA and ME)		
Joints	Slope[a]	Intercept[a]	RSD	Slope[a]	Intercept[a]	RSD
Hind shin	0.54 0.20 –0.11	Not estimate	28.2	0.11	637.01 627.27 638.33 654.00	29.96
Leg	1.16	–206.67	13.91	0.97	–60.69	17.11
Sirloin	0.49	395.36 298.46 318.30	26.36	0.82	45.54	24.31
Thin flank	0.25	485.29 495.78 506.88	21.20	0.26	494.24 490.22 495.87 508.32	18.44
Ribs	0.56	305.11 318.84 323.64	19.04	0.52	338.48	15.35
Middle coast	0.38	417.44 436.24 444.05	20.61	0.36	443.96 435.18 442.70 457.50	20.49
Coast	0.44	465.49	18.45	0.38	499.03	22.48
Fore ribs	0.51	279.50 284.04 299.72	23.88	0.66	170.84	23.72
Shoulder	0.92	–67.51	20.81	1.02	–148.67	19.08
Fore shin	0.41	487.34 481.10 502.09	22.67	–0.008 0.033 0.09 0.42	Not estimate	30.52
Neck	0.41	491.72	26.95	0.40	370.34	25.52

For abbreviations, see Table I. [a] When not homogeneous the individual parameters for each breed are shown.

agree with the findings of many other workers [12, 22] for extreme beef and dairy breeds and confirm that there is little variation between breeds in the distribution of fat in each joint.

Concerning the homogeneity of the parameters, the regression slope of muscle concentration on sample joints showed little evidence of variation among breeds, except the hind shin in large breeds and the fore shin in small breeds. Differences in intercept among large breeds for the sirloin, thin flank, ribs, middle coast, fore ribs, and fore shin joints, covering a range 96.9, 21.59, 18.53, 26.61, 20.22 and 20.99 $g \cdot kg^{-1}$, respectively, and among small breeds for the hind shin, thin flank, and middle coast joints covering a range of 26.73, 18.1, and 22.32 $g \cdot kg^{-1}$ respectively, were also found (Tab. VI). These differences were rather unexpected since the differences between breeds for the distribution of muscle in each joint were small (Tab. III).

As expected the joints with homogeneous parameters that were not significantly different between breeds, were the most accurate. Concerning large breeds, the most accurate joints were the leg, with a residual s.d. of 13.91 $g \cdot kg^{-1}$ and the coast with a residual s.d. of 18.45; and in small breeds the most accurate were the fore ribs, with a residual s.d. of 15.35 $g \cdot kg^{-1}$ and the leg, with a residual s.d. of 17.11 $g \cdot kg^{-1}$, approaching the values of Kempster et al. [15], for similar joints.

Common regression equations for the most important predictors and differences ($g \cdot kg^{-1}$) between the actual mean and the predicted mean for each breed are given in Table VII. On an individual breed basis, all the means predicted from the leg and coast joints in large breeds, and from the fore ribs and the leg in small breeds were within ± 4 $g \cdot kg^{-1}$ of the actual values, excepted for BA, which was –8 $g \cdot kg^{-1}$ lower. The most likely explanation for this difference, –8 $g \cdot kg^{-1}$, seems to be a similar 80 $g \cdot kg^{-1}$ in the fore ribs, or a higher proportion of muscle in the leg, 325 $g \cdot kg^{-1}$, in relation to total muscle in the carcass ($g \cdot kg^{-1}$) with the same proportion of total carcass fat (Tab. III). The proportions of muscle in the carcass of BA tended to be the lowest among breeds, also at the same proportion of total carcass fat, according to Simões and Mira [21].

As a general conclusion, the extent of the distribution of tissues in joints between breeds, even when statistically significant, was not large enough to have a commercial relevance. In contrast to subcutaneous fat, the proportion of intermuscular fat tended to decrease, particularly in the leg joint. In large and small breeds, the coast and fore ribs, respectively, are good alternatives to predicting the proportions of muscle in the carcass from the proportion of muscle in the joint, when full carcass dissection is not possible.

Table VII. Regression equation computed overall for the most important predictors and differences ($g \cdot kg^{-1}$) between the actual mean and the prediction mean for each breed, where Y is the proportion of muscle ($g \cdot kg^{-1}$) in the side and X is the proportion of muscle ($g \cdot kg^{-1}$) in the joint.

Large breeds		
	Leg	Coast
	Y = – 212.54 + 1.17X	Y = 456.84 + 0.46X
AL	3.47	–1.94
MI	–0.30	–3.06
MO	–0.73	1.01
Small breeds		
	Fore ribs	Leg
	Y = 327.18 + 0.54X	Y = 767.77 + 0.99X
AR	1.54	–2.31
BA	–8.10	–8.34
MA	–1.83	0.21
ME	3.79	–2.14

For abbreviations, see Table I.

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