

Carcass characterisation of seven Spanish beef breeds slaughtered at two commercial weights

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Abstract

A total of 159 bulls representing seven Spanish beef breeds were fed with concentrates, managed in the same conditions and slaughtered at two commercial weights (veal and young-bull). Carcasses were measured and classified in order to characterise the carcass variation in the Spanish beef market and to assess the relationship among carcass measurements and grading. Principal Component Analysis clearly separated commercial types regardless the inclusion of the carcass weight in the input data. Within commercial weights the studied breeds clustered into three groups according to muscular development and carcass classification score: high meat producer breeds (Asturiana de los Valles and Rubia Gallega); medium meat producers (Parda Alpina and Pirenaica); and low meat producers (Avileña, Retinta and Morucha). The perimeter and width of the leg (muscular development) besides the length and width of the carcass basically defined these three carcass types. Conformation was an important trait in explaining variation between breeds because its values were positively correlated with muscular development and carcass compactness.

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1. Introduction

The modern meat market demands well muscled carcasses with a high percentage of lean meat and a certain degree of fatness to prevent weight loss during cold storage, while maintaining sensory quality. As meat quality traits are not normally considered commercially, carcass classification for conformation and fatness determine the market price, within each carcass weight range. Breeds with the best conformation tend to be more economically valuable and poor conformation is penalised. Therefore if a carcass is graded as S, E, U, R, O or P the price reduction tends to be progressive, varying from 6% to 10%, and the final economic value can vary by more

than 60€ between two consecutive grades (Albertí, Sañudo, Olleta, Panea, & Lahoz, 2001; Mercolleida, 2004). Economic profit for each carcass is dictated by the classification, so it should be accurate and objective.

Spanish feedlots usually raise crossbred bulls. However, there are also many native beef breeds on the Spanish beef market. The carcass characteristics of local breeds vary widely, from rustic animals with poor conformation to specialised beef breeds (i.e., Asturiana de los Valles), with well conformed lean carcasses due to a myostatin gene mutation that produces muscular hypertrophy (Grobet et al., 1997). Recently, several studies have been carried out to characterise meat and carcass quality in the most important local beef breeds produced under different typical production systems (Gil et al., 2001; Piedrafita et al., 2003; Serra et al., 2004). However, there is no available information about

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the carcass characteristics of local Spanish beef breeds when the same commercial concentrate diets and management are used. This is necessary to ascertain the actual influence of the breed to produce the desired specific product to attain the market demands.

Moreover, Díez et al. (2003) have recently reported that the assessment of carcass conformation is not affected by the same traits for light (veal-type) or standard (young-bull) carcasses. So, carcass conformation should be evaluated separately at both commercial weights.

Principal Component Analysis (PCA) is helpful to understand results of manifold variables. Recently, PCA has been used to characterise European bovine beef breed carcasses, and even discriminate hypertrophied animals based on analytical meat quality measurements (Destefanis, Barge, Brugiapaglia, & Tassone, 2000). PCA reveals linear relationships between traits and computes unobservable, hypothetical variables (also known as factors) that explain most of the variability. Coefficients computed for each factor show the relative contribution of individual carcass traits for a specific component. According to the sign and magnitude of the coefficients, factors can be biologically interpreted, allowing the identification of major traits.

In this study, males from seven Spanish beef breeds with a large range of variation in carcass characteristics were fed using the same commercial diet and management and slaughtered at two different commercial weights. Conformation and fatness scores were obtained besides six different carcass measurements and carcass weight to fulfil the following goals: (a) to determine the importance of carcass measurements on carcass conformation grading; and (b) to characterise the variation in carcass type within the Spanish beef market.

2. Materials and methods

We analysed the carcasses from 159 entire males from seven Spanish breeds. They were fed ad libitum with concentrate and cereal straw until two different slaughter weights: “veal-type” (83 individuals) and “young-bull” (76 individuals). The beef breeds and the number of individuals per feedlot (veal-type first) included in the study were: Asturiana de los Valles (AS, 12, 9), Avileña (AV, 11, 12), Morucha (MO, 12, 11), Parda Alpina (PA, 12, 12), Pirenaica (PI, 12, 11), Retinta (RE, 11, 11) and Rubia Gallega (RG, 13, 10). Animals of the same breed and commercial weight were lodged in one pen. Veal-type and young-bull animals were slaughtered at an average live-weight of 330 and 550 kg, respectively.

The concentrate used to feed the veal-type animals had 18.0% crude protein and 2.9 Mcal ME/kg dry matter. The young-bulls were fed firstly the same diet and then a concentrate with lower crude protein with 15.5% and 3.1 Mcal ME/kg dry matter.

After slaughter, carcasses were weighed and 2% of the carcass weight was subtracted to determine the cold carcass weight (CCW). Then carcasses were chilled for 24 h at 4 °C and the following assessments and measurements were carried out on the left half:

1. Carcasses were classified using the EUROP classification scale (Anonymous, 1981) for conformation (CONF) (E excellent; U very good; R good; O fair; P poor) scoring from 15 for E+ to 1 for P-. For the fat cover (FC) classification (1 low; 2 slight; 3 average; 4 high; 5 very high) the score was 15 for 5+ very high to 1 for 1-.
2. Carcass measurements were recorded according to the method of De Boer, Dumont, Pomeroy, and Weniger (1974):
 - Length of carcass (LC), measured from the anterior edge of symphysis pubis to the middle of the anterior edge of the visible part of the first rib.
 - Length of hind leg (LL), measured from the medial malleolus of the tibia in a straight line to the anterior edge of the symphysis pubis.
 - Width of leg (WL), measured as the horizontal distance between the outermost points on the medial and the lateral surface of the leg.

Other shape-related characteristics included in the analysis were:

- Width of carcass (WC), measured from the last sternebra to the dorsal tip of the spinous process of the sixth thoracic vertebra.
- Depth of hind leg (DL), measured as the horizontal distance between the outermost points on the anterior and posterior surface of the leg.
- Perimeter of leg (PL), the maximum measurement of the horizontal contour of the leg at the symphysis pubis level.

Length and perimeter measurements were taken by tape measure, whereas width and depth measurements were taken by calliper.

PCA was performed using these nine variables for all 159 animals to determine the number of independent traits that account for most of the variation in carcass traits. We used the SAS statistical package v. 8.1 (SAS, 1997). The analysis was computed from the phenotypic correlation matrix among traits to ensure that all traits were treated as equally important, giving the same weight to the variables regardless of their own variance. Only factors accounting for more variation than any individual type trait (eigenvalue ≥ 1) were retained. A VARIMAX rotation (SAS, 1997) was applied to the retained components to redistribute the variance among factors to obtain factor pattern coefficients. The resulting rotated factors are considerably less correlated than

the original carcass traits, making it easier to interpret the components without changing their explanatory power. The PCA was repeated with the sub samples of 83 veal and 76 young-bulls. The data to compare the means for the nine variables of veal and young-bull category were analysed using the GLM procedure. Finally, we computed the phenotypic correlation among traits.

3. Results

A summary of the means, standard deviations and coefficients of variation for carcass weight, carcass measurements and conformation and fatness classification scores is provided in Table 1 for each slaughter weight group. The average values of both commercial classes differed significantly ($p < 0.01$) for all the traits except conformation grading ($p < 0.05$). Average carcass weight was 187.7 kg for the veal-type sample and 326.8 kg for the young-bull type. Carcass conformation and fat cover scores were lower for the veal category (8.7 and 3.9, respectively) than for the young-bull type

(9.8 and 6.2, respectively). However, both commercial weights had the same mean score for both conformation (R class; good muscle development, profiles on the whole straight) and fat cover (2; slight fat cover, flesh visible almost everywhere, within the thoracic cavity the muscle was clearly visible between the ribs). The means of all analysed traits increased from veal to young-bull while most coefficients of variation decreased, with a larger variation within the veal-type category, especially regarding CONF, WL, DL (muscular development traits) or LL. Only the variation in LC was slightly larger within young-bull than for veal.

Correlation coefficients among carcass traits are given in Tables 2 and 3 for veal-type and young-bull subsets, respectively. Correlations between variables related to the volume of the leg, such as WL, DL and PL were highly significant for both commercial categories. However, the correlations among these muscle related variables and those related with carcass size or skeletal size, such as LC and WC, differed between commercial categories. They were positive for the veal-type subset but negative and more significant for the young-bull carcasses. The changes in conformation score, as a subject-

Table 1
Mean, standard deviation (SD) and coefficient of variation (CV) of the variables from 159 carcasses of veal and young-bull commercial categories

n/type	83 veal			76 young-bull			P-value
	Mean	SD	CV	Mean	SD	CV	
Carcass weight (kg)	187.7 ^a	36.48	19.4	326.8 ^b	36.73	11.2	0.001
Conformation ^c	8.7 ^c	3.09	35.3	9.8 ^d	2.99	30.5	0.022
Fat cover ^e	3.9 ^a	1.58	40.5	6.2 ^b	1.88	30.4	0.001
Length of carcass (cm)	109.8 ^a	4.28	3.9	127.9 ^b	5.38	4.2	0.001
Width of carcass (cm)	51.8 ^a	2.72	5.3	61.0 ^b	2.90	4.7	0.001
Length of leg (cm)	71.7 ^a	3.31	4.6	81.0 ^b	2.77	3.4	0.001
Width of leg (cm)	23.8 ^a	3.48	14.7	28.1 ^b	2.98	10.6	0.001
Perimeter of leg (cm)	102.0 ^a	7.87	7.7	117.6 ^b	8.12	6.9	0.001
Depth of leg (cm)	38.0 ^a	2.57	6.8	43.2 ^b	2.33	5.4	0.001

^a Means with different superscript letter differ ($P < 0.01$).

^b Means with different superscript letter differ ($P < 0.01$).

^c Means with different superscript letter differ ($P < 0.05$).

^d Means with different superscript letter differ ($P < 0.05$).

^e Conformation and fat scores 1–15.

Table 2
Correlation coefficients among variables of veal category

	LC ^a	WC	LL	WL	PL	DL	CCW	CONF
WC	0.62 ^{***}							
LL	0.76 ^{***}	0.57 ^{***}						
WL	0.24	-0.01	0.27					
PL	0.42 ^{***}	0.12	0.51 ^{***}	0.89 ^{***}				
DL	0.44 ^{***}	0.20	0.51 ^{***}	0.70 ^{***}	0.85 ^{***}			
CCW	0.60 ^{***}	0.32 ^{**}	0.65 ^{***}	0.82 ^{***}	0.93 ^{***}	0.80 ^{***}		
CONF	0.12	-0.12	0.17	0.84 ^{***}	0.82 ^{***}	0.66 ^{***}	0.73 ^{***}	
FC	0.17	0.25	0.06	-0.52 ^{***}	-0.44 ^{***}	-0.21	-0.28	-0.47 ^{***}

^a LC, length of carcass; WC, width of carcass; LL, length of leg; WL, width of leg; PL, perimeter of leg; DL, depth of leg; CCW, cold carcass weight; CONF, conformation score classification; FC, fat cover classification.

** $P < 0.01$.

*** $P < 0.001$.

Table 3
Correlation coefficients among variables of young-bull category

	LC ^a	WC	LL	WL	PL	DL	CCW	CONF
WC	0.55***							
LL	0.48***	0.35**						
WL	-0.37	-0.37**	-0.19					
PL	-0.39***	-0.41***	-0.18	0.93***				
DL	-0.34**	-0.32**	-0.10	0.85***	0.90***			
CCW	0.09	-0.15	0.10	0.72***	0.78***	0.69***		
CONF	-0.58***	-0.49***	-0.31**	0.81***	0.86***	0.72***	0.64***	
FC	0.56***	0.41***	0.32**	-0.64***	-0.67***	-0.62***	-0.36***	-0.65***

^a Abbreviations see Table 2.

** $P < 0.01$.

*** $P < 0.001$.

tive measure of muscularity, were similar to traits related with the volume of the leg. The correlations between CONF and most of the leg measurements were positive and significant for both commercial categories (especially with PL and WL). However CONF was not correlated (for veal-type) and negatively and significantly correlated (for young-bull category) with traits related with carcass size such as LC and WC. FC was negatively correlated with CONF and other muscular development traits such as WL and PL in both categories. However, FC was only significantly correlated with the main carcass size variables (LC, WC and LL) in the young-bull category.

Results from the PCA are given in Table 4. Only two components were retained after analysing the whole data set and each commercial subset. The first component explained 64.7% of the whole dataset, 55.1% of the veal-type carcasses and 57.6% of the young-bull category. The variability explained by the second factor was 25.5%, 25.4% and 19.6%, respectively. The first component was basically formed by traits related to leg muscular development, especially WL, PL and DL, as well as CONF. The second component mainly explained the carcass size (LC, WC and LL). Carcass

weight contributed to both principal components for the whole dataset but only to the first component for each weight category. Conformation tended to be negatively related to the second component except for veal carcasses where its contribution was almost zero. The fat cover score was not related to carcass size traits, except for the whole dataset.

Fig. 1 summarises the location of each breed/commercial category in the multivariate space formed by the first two principal component score vectors. The scores clustered in two main groups, which coincided with the two commercial categories analysed, showing that between categories differences were larger than those observed between breeds. Within each commercial weight, the breeds can be separated into three groups: (a) Retinta, Morucha and Avileña; (b) Rubia Gallega and Asturiana de los Valles; and (c) the intermediate Parda Alpina and Pirenaica. Regardless of the commercial category, Retinta, Morucha and Avileña clustered together. However, there were slight differences for Rubia Gallega and Asturiana de los Valles in the veal category and for the intermediate breeds in the young-bull subset. Even though there was no difference for young-bulls, the Rubia Gallega veals tended to have larger car-

Table 4
Results from the Principal Component Analysis of seven beef breeds slaughtered at veal and young-bulls commercial categories

Variable	Whole dataset		Veal		Young-bulls	
	PC 1	PC 2	PC 1	PC 2	PC 1	PC 2
Length of carcass	0.31	0.92	0.19	0.89	-0.17	0.87
Width of carcass	0.25	0.91	-0.11	0.83	-0.26	0.69
Length of leg	0.39	0.86	0.28	0.84	0.04	0.76
Width of leg	0.94	0.19	0.94	0.07	0.91	-0.25
Perimeter of leg	0.91	0.37	0.93	0.30	0.95	-0.26
Depth of leg	0.82	0.47	0.77	0.40	0.90	-0.18
Carcass weight	0.71	0.68	0.83	0.51	0.90	0.22
Conformation	0.90	-0.25	0.91	-0.05	0.79	-0.46
Fat cover	-0.28	0.84	-0.63	0.39	-0.59	0.55
Eigenvalues	5.82	2.30	4.96	2.28	5.18	1.77
% of variance	64.71	25.52	55.14	25.40	57.61	19.62
Cumulative variance (%)	64.71	90.23	55.14	80.54	57.61	77.23

(Eigenvectors $\geq |0.67|$ whole data set; $|0.63|$ veal; $|0.62|$ young-bull, are in bold.). The value is the root mean square of all the values in the matrix being printed.

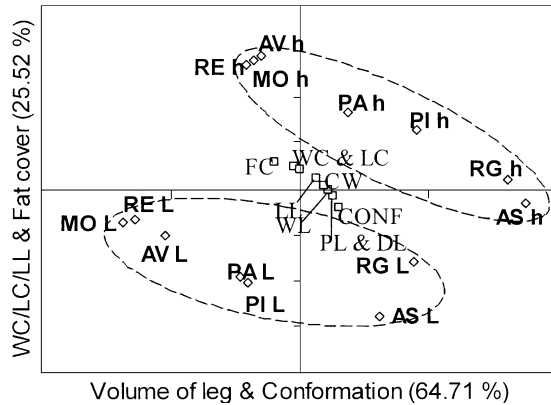


Fig. 1. Principal Component Analysis of carcass characteristics of seven bovine breeds slaughtered at light weight (L) veal category and heavy weight (h) young-bull category. LC, length of carcass; WC, width of carcass; LL, length of leg; WL, width of leg; PL, perimeter of leg; DL, depth of leg; CCW, cold carcass weight; CONF, conformation score classification; FC, fat cover classification; L, light-weight veal category; h, heavy-weight young-bull category. Breeds: AS, Asturiana de los Valles; AV, Avileña; MO, Morucha; PA, Parda; PI, Pirenaica; RE, Retinta; RG, Rubia Gallega.

carcasses with higher slaughter weights than those from Asturiana de los Valles and the other breeds. On the other hand, Pirenaica and Parda Alpina had very similar carcasses for the veal-type category but Pirenaica tended to show a better CONF than Parda Alpina for young-bulls (data not shown).

4. Discussion

This study includes a representative sample of the variation in conformation classes and carcass weights available on the beef market in Spain. The two commercial products analysed here characterise a market in which most beef is from animals in the early stages of puberty or young adults. This is also reflected in the fatness scores assessed in the seven Spanish beef breeds. Fatness levels were high enough for the Spanish market, where scores above 3 are penalised. In addition, the analysed database reflects the preference of some local markets for lean meat, as produced by Rubia Gallega and Asturiana de los Valles, especially on veal-type. There were large differences within and, specially, between commercial classes, which were reflected in the high standard deviation computed for the recorded traits. This was especially true for veal-type individuals (see Table 1) where there were large coefficients of variation for traits such as FC. Differences among breeds and commercial classes can help to provide reliable biological interpretations of factors affecting beef carcass characteristics (Brännäng, 1975).

As observed when carcasses increase in weight (Kempster, Cook, & Southgate, 1988; More O'Ferrall & Keane, 1990), or between light and standard bovine

carcasses (Díez et al., 2003), all carcass dimensions and assessments (CONF and FC) increased with increasing weight from the veal-type animals to young-bulls. In addition, traits that made a major contribution to the retained component were consistently the same when the PCA was carried out within each commercial category. This would imply that the detected patterns of variation are regular across commercial types. However, this general conclusion, of evidence of a regular pattern of variation, is qualified by the interrelations of CCW, CONF and FC. In any case, CONF did not increase with slaughter weight as much as FC (Table 1). The contribution of CONF to the first component was more important for the veal carcasses. For the young-bull category, muscular development was mainly defined by objective measurements (WL, PL, DL and CCW). Moreover, CONF and CCW did not follow the same pattern of variation: CCW was only related to carcass size traits for the veal-type dataset, while CONF and the carcass size components were not related for the veal-type carcasses and negatively related for young-bulls (Table 4). Considering all these results, it is possible to argue that the relationships among carcass grading scores and carcass measurements are not consistent between the veal and young-bull categories. Within young-bull carcasses and from high to low meat producers the analysed traits follow a clear pattern of variation (Table 5): CONF and muscular development traits decrease while carcass size and FC increase. However, the veal-type carcasses do not follow exactly this pattern since carcass size traits are the same for the high and low meat producers but lower for the medium group. Regardless the type of carcass assessed, the young-bulls are easy to grade with accuracy because the different anatomical traits always vary in the same direction; however, veal carcasses are more difficult to grade and classifiers use carcass size measures in a changeable-intuitive sense when facing a given carcass.

Our findings agree with Díez et al. (2003), who concluded that conformation should be assessed within carcass weight classes. They report that the classification of young-bull carcasses is more accurate because the classifiers have enough information to grade the product according to the SEUROP definition when considering young adults. However, to correctly assess veal carcasses classifiers need to consider attributes like carcass size or the degree of skeletal development in a non-linear way. In fact, when classifiers graded veal-type carcasses they did not use carcass size traits in the same direction for each level of muscular development (Díez et al., 2003.). This kind of non-linear relationships can not be ascertained by PCA that only accounted for linear relationships between the traits included in a dataset. In the present study, CONF was not correlated with carcass size traits for the veal-type, while it was negative and significantly correlated for the young-bull category.

Table 5

Mean and standard deviation for the traits of the three groups of carcasses identified by means of Principal Component Analysis by veal-type and young-bull commercial categories^A

	High meat producers		Medium producers		Low meat producers	
	AS, RG		PA, PI		AV, MO, RE	
	Veal	Young-bull	Veal	Young-bull	Veal	Young-bull
Category: <i>n</i> :	25	19	24	23	34	34
LC (cm)	111.3 ^d ± 4.87	122.5 ^c ± 3.85	108.0 ^e ± 3.64	127.1 ^b ± 4.44	110.1 ^{de} ± 3.87	131.3 ^a ± 3.95
WC (cm)	52.1 ^{de} ± 3.77	58.4 ^c ± 1.79	50.3 ^e ± 2.09	60.3 ^b ± 1.89	52.5 ^d ± 1.73	62.9 ^a ± 2.63
LL (cm)	73.5 ^c ± 3.79	79.8 ^b ± 2.68	69.7 ^d ± 2.67	80.1 ^b ± 3.07	71.9 ^c ± 2.50	82.2 ^a ± 2.12
WL (cm)	28.0 ^b ± 1.68	31.5 ^a ± 2.18	24.1 ^d ± 1.71	28.8 ^b ± 2.14	20.5 ^e ± 1.32	25.8 ^c ± 1.44
PL (cm)	111.5 ^c ± 4.62	127.3 ^a ± 4.95	101.2 ^d ± 3.22	119.8 ^b ± 5.32	95.4 ^c ± 4.17	110.7 ^c ± 3.31
DL (cm)	40.5 ^c ± 2.55	45.7 ^a ± 1.48	37.2 ^d ± 1.41	43.4 ^b ± 1.97	36.7 ^d ± 1.79	41.6 ^c ± 1.52
CCW (kg)	230.1 ^c ± 30.54	354.0 ^a ± 37.11	180.0 ^d ± 16.72	335.4 ^a ± 32.41	162.0 ^d ± 18.63	305.8 ^b ± 26.14
CONF ^B	12.5 ^b ± 1.64	13.6 ^a ± 1.07	8.7 ^d ± 1.01	10.5 ^c ± 1.90	6.1 ^f ± 1.70	7.2 ^e ± 1.19
FC ^B	2.6 ^c ± 1.50	3.8 ^d ± 0.98	3.8 ^d ± 1.25	6.3 ^b ± 1.19	4.9 ^c ± 0.98	7.4 ^a ± 1.28
Blockiness (kg/cm)	2.1 ^d ± 0.20	2.9 ^a ± 0.24	1.7 ^e ± 0.11	2.7 ^b ± 0.19	1.5 ^f ± 0.13	2.4 ^c ± 0.16

Within a row, means without a common superscript differ ($P < 0.01$).

^A Abbreviations see Table 2.

^B Conformation and fat score 1–15.

Other evidence supporting these statements arises from the analysis of the carcass blockiness (Table 5), defined as the ratio CCW/LC, which denotes the carcass compactness. In young-bulls the increase of blockiness from low to high meat producers is rather constant while a clear leap can be assessed from medium to high meat producers for the veal-type.

Moreover, when the whole dataset was analysed, the contribution of CCW to the factors retained in the PCA appears to be over weighted with respect to the other objective measurements. If the carcasses were analysed as a whole, without considering commercial class, we could have concluded that carcasses can be characterised by CCW only. As our commercial categories are defined using the carcass weight the inclusion of this trait could have determined the PCA results. In consequence, the reliability of the reported results was checked by re-analysing the dataset without including carcass weight. The results of the re-analysis (not shown) were consistently the same showing that the inclusion of CCW does not substantially affect the confidence on the analysis.

A major issue arising from the present study is that carcass traits can differentiate groups of products regardless of the carcass weight category. Table 5 gives the average values (for both veal and young-bull commercial types) of the analysed traits for the three groups of breeds identified using PCA. According to the average values, the groups of breeds can be described as:

(a) High meat producers, with late maturing and short carcass size, producing highly muscled carcasses (CONF between E– and U+) with high blockiness and a low FC: Asturiana de los Valles and Rubia Gallega breeds.

(b) Medium meat producers with medium maturing and medium values of blockiness, CONF (between R+ and U) and FC: Pirenaica and Parda Alpina breeds.

(c) Low meat producers, with early maturing and large carcass size, producing low muscled carcasses (CONF between O– and O+ classes) with high FC and low blockiness: Avileña, Retinta and Morucha breeds.

Leg traits related to muscular development (WL, PL and DL) have higher values in high meat producers than in low meat producers for both veal and young-bull carcasses. On the other hand, those traits related to carcass size (LC and WC) have lower average values in high meat producers than in low meat producers for the young-bull category while they have similar values for the veal-type. This illustrates the higher carcass compactness of the high meat producer breeds (Asturiana de los Valles and Rubia Gallega).

The groupings of carcass types identified by PCA are consistent with previous reports. Vallejo et al. (1992) analysed the phenotypic correlations between live and carcass traits in Asturiana de los Valles and defined it as late maturing. Classification score, carcass and leg measurements reported in the present study for Parda de Alpina are within the range of values reported by Serra et al. (2004), who define it as medium-big-framed. As in Piedrafita et al. (2003), the long carcasses and hind limbs of MO, AV and RE allow us to define them as large framed and their high fatness scores as early maturing breeds. In general, carcasses from the later-maturing breeds have less fat and heavier hindquarter cuts (Purchas, Barton, & Hunt, 1992). A previous study showed that Asturiana de los Valles has a low fat cover score compared to the other six beef breeds when

young-bulls are slaughtered at an average live weight of 460 kg (Albertí et al., 1997).

Moreover, there was an important ecological, productive and genetic consistency between the three types of carcasses identified. The specialised beef breed herds (AS and RG) are produced in humid North-western Spain on small farms with a high proportion of doubled muscled individuals (Martínez et al., 1999; Monserrat et al., 1995). The high meat breeds (PI and PA) are produced in the Pyrenean mountains, mainly rearing herds in valley–mountain (transhumance) system (Alzueta et al., 1999; Sanz, Bernués, Villalba, Casasús, & Revilla, 2004; Villalba, Casasús, Sanz, Estany, & Revilla, 2000). The herds of the medium meat producers (AV, RE and MO) are managed in large farms and extensive grazing systems in the semi-arid “dehesas” (meadows) of Midwestern and South-western Iberian Peninsula (García-Torres, López-Parra, Robles-Lobo, Izquierdo-Cebrián, & Espejo-Díaz, 2003). Usually, after weaning, the calves of these breeds are fed on concentrate diets (Albertí, 1995; Albertí et al., 1997).

Carcasses from most breeds considered here have been characterised in terms of their typical production systems (Piedrafitá et al., 2003). Thus, the variability between breeds can be due to genetic factors, management or rearing practices. All the individuals in this study were reared under the same commercial-like methodology and slaughtered at weights that were not always typical (i.e., veal carcasses for the medium meat producer breeds). However, the variation between breeds was apparent and consistent with the aforementioned within breed analysis. From our results we can suggest that the main characteristics that define carcasses from local Spanish beef breeds depend more on the genetic background than on the age of slaughter or particular rearing systems.

5. Conclusions

Seven beef breeds were analysed and grouped into three types according to muscular development, carcass size and precocity of fat deposition. The differences among and within the three types were maintained at the veal or young-bull commercial categories. Considering the whole data set, commercial type differences were larger than those between breeds in muscular development and carcass classification.

Retinta, Morucha and Avileña breeds were characterised by long carcasses with low conformation, and a high subcutaneous fat cover. Asturiana de los Valles and Rubia Gallega had the most compact carcasses with mostly convex profiles and very good muscle development (especially on the leg). Pirenaica and Parda Alpina had carcasses with intermediate characteristics between these groups. When the slaughter weight increased, Pire-

naica tended to differ from Parda Alpina due to its higher muscle development.

There was a high correlation between conformation, width, depth and perimeter of leg at both carcass weights. The correlation between conformation and fat cover was highly significant and negative. The perimeter and the width of leg (which defines leg development), appear to be the most important traits in both categories (veal and young-bull), along with the length or width of the carcass, that can be used to group the different breeds. Conformation was an important trait in explaining variation between breeds because its values were positively correlated with muscular development and carcass compactness. Moreover for young-bull category, the carcass conformation grading could be done with more accuracy when carcass size was taking into account, which was negatively correlated with conformation.

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