Czech Journal of ANIMAL SCIENCE

Volume 51, No. 11 **November 2006**

CONTENTS

ORIGINAL PAPERS

Adult steers for beef production: breed effect on animal performance, retail yield and carcass quality

C. Vieira[1], A. Cerdeño[2], E. Serrano[2], A.R. Mantecón[2]

[1]Estación Tecnológica de la Carne, Instituto Tecnológico Agrario de castilla y León, Guijuelo, Salamanca, Spain

[2]Estación Agrícola Experimental, Consejo Supervisor de Investigaciones Científicas, León, Spain

ABSTRACT: The production of adult steers for beef could be a profitable use of the territory in some mountain areas in the south of Europe, where this production is nearly inexistent, owing to an increase in the demand for meat from adult animals in specialized markets. The objective of this study was to evaluate the profitability of beef production in three breeds adapted to these areas but varying greatly in their mature size. The studied breeds were a specialized meat breed Limousin, a dual-purpose breed – Brown Swiss breed and – a Spanish local breed Asturiana de los Valles. Higher growth rates ($P < 0.05$) and higher carcass weights ($P < 0.05$) were achieved by Brown Swiss and Limousin. In relation to carcass value, better results of dressing percentage ($P < 0.001$), conformation ($P < 0.001$) and saleable meat percentages ($P < 0.001$) were obtained by Limousin. Due to preferences of the adult steers market for carcass with high fatness, Brown Swiss and Limousin could be more suitable to make this production profitable than Asturiana de los Valles (4.7 and 4.2 vs. 2.7, respectively, on the EUROP scale).

Keywords: adult steers; carcass quality; breed effect; retail yield

In some European mountain areas, the natural constraints due to the climate and geography seem to be unfavourable to mass meat production at a low cost; thus alternatives to make the use of the territory profitable are needed. In this framework, beef production from adult castrated males under traditional production systems could be an interesting alternative in those areas where this production is nearly inexistent, such as those situated in the northwest of Spain. In this sense, the profitable use of pastures supplemented with conserved forages and small amounts of cereals could be considered a tool for achieving the objective of sustainable meat production, at the same time meeting the European Union requirements for production system extensification and territory utilisation to maintain the population in rural areas (Andersen et al., 2005). On the other hand, in recent years the demand for meat from this type of adult castrated males has increased, overall in restaurants and specialized markets. However, production systems must take into account genetic and management variables as well as economic and biological efficiency to determine an optimum arrangement for beef production (Short et al., 1999). Bearing in mind that the production of adult steers for beef should be based on breeds settled in mountain areas, a comparative analysis of the most common breeds in these areas under the same production conditions is needed. Although many papers describing the characteristics of pure or crossbred castrated males from a large number of breeds were published (Camfield et al., 1999; Short el al., 1999; Keane and Allen, 2002), a limited number of studies have been carried out in animals at the age of more than three years. The objective of this experiment was to establish breed differential characteristics under the same production system in order to prove their adequacy for beef production.

MATERIAL AND METHODS

Animals and experimental design

At the Agricultural Experimental Station of the Spanish Council for Scientific Research (CSIC) in León (NW of Spain) an experiment was conducted on 24 animals in total, belonging to four genotypes (6 animals per breed): European Brown Swiss as a dual-purpose breed, American Brown Swiss as a dairy breed, Limousin as a specialized beef breed and Asturiana de los Valles as a Spanish local breed. Animals were born in spring and reared on pasture with their dams until early October, when they were weaned. At the moment when the experiment started, the animals had an average age of 8 months and initial weight ranging from 220 to 260 kg. The experimental period lasted for three years until slaughter that was carried out at 42 months of age. At arrival, the animals were housed together and they were offered the same feeding strategy. The animals were castrated at 10 months of age. The facilities consisted of two different parts: an indoor area of 900 m^2 with concrete floor and straw bedding, and an adjacent ground exercise yard of 1 500 m^2 in size. An irrigated pasture was also available for grazing from June to October. The feeding strategy was fixed taking into account available natural resources in each season, maximizing forage intake, with increasing amounts of concentrate offered daily: 3 kg/animal in the first year of experiment, 6 kg/animal in the second year and 10 kg/animal in the third year, in order to obtain a desirable fat cover at slaughter. Forage used in each season was distributed as follows: from November to January the animals were offered lucerne hay *ad libitum* every day; from February to May the animals received 10 kg/animal of medium-quality silage and 4 kg/animal of lucerne hay every day; and from June to October the animals grazed on an irrigated pasture 10 hours a day. The concentrate was composed of 35% maize, 32.4% barley, 12% soybean meal, 10% lupin, 4.5% molasses, 3% by-pass fat and 3.1% vitamin and mineral premix (phosphate, carbonate and salt included). The concentrate contained (%DM) crude fibre (5.1%), acid detergent fibre (6.5%), neutral detergent fibre (13.7%), sugars (4.7%), starch (39.2%), crude protein (14.8%), ether extract (5.5%), and ash (5.3%). Calves were weighed at the beginning of the experiment, then at 2-month intervals to determine average daily gain by linear regression. The day before slaughter the animals were weighed and the transport to an authorised EU commercial abattoir lasted 1 hour.

Table 1. Characteristics of animals during the experimental period and the fifth quarter composition

Parameters	Asturiana de los Valles	Limousine	Brown Swiss	RSD	*P*
Growth rate (kg/day)					
1st and 2nd year of experiment	0.75	0.74	0.82	0.11	ns
3rd year of experiment	0.50[a]	0.68[b]	0.68[b]	0.12	*
Slaughter conditions					
Slaughter live weight (kg)	826.92[a]	909.83[ab]	941.07 [b]	88.49	*
Age (months)	42.21	43.03	42.62	0.431	ns
Non-carcass parts (% live weight)					
Head	3.11	2.82	2.98	0.251	ns
Full digestive tract	15.53[a]	12.80[b]	15.03[a]	1.186	**
Hide	5.92	5.93	6.26	0.503	ns
Tail	0.28	0.27	0.26	0.200	ns
Liver, heart and lungs	2.80[a]	2.51[b]	2.67[ab]	0.306	*
Kidneys	0.14	0.13	0.15	0.001	ns
Horns, ears and hoofs	2.39[a]	2.06[b]	2.34[a]	0.145	**
Kidney-pelvic fat	1.07[ab]	0.95[a]	1.26[b]	0.176	**

**$P < 0.01$; *$P < 0.05$; ns = $P > 0.05$

[a,b]values with different superscripts indicate significant differences between breeds ($P < 0.05$)

Slaughter measurements and carcass characteristics

Once the animals were slaughtered, the following parts belonging to the fifth quarter were separated and weighed: horns, ears, tail, hoofs, hide, head, digestive tract, kidneys, liver, kidney-pelvic fat, lungs and heart. The weights were expressed as a percentage of live weight. Carcasses were graded visually for conformation and fatness according to the EUROP beef carcass grading system. Conformation score was assessed with a scale ranging from 5 (E, very good conformation) to 1 (P, very poor conformation). Fatness was measured using a scale ranging from 5 (very high) to 1 (very low). Carcasses were weighed about 1 h *post mortem* and after 24 h at 4°C. Dressing percentage was calculated as the ratio between hot carcass weight and slaughter body weight. In 24 h *post mortem*, pH values were recorded in the *musculus semimembranosus* and *musculus longissimus lumborum* (3rd lumbar vertebra) using a Metrohm 704 pH-meter. The following linear measurements were recorded on the left carcass side (De Boer et al., 1974): carcass length, hind limb length, hind limb width and hind limb perimeter. Subcutaneous fat depth was measured at the 6th rib level. To assess the carcass external colour, colorimetric parameters were obtained on subcutaneous fat and on subcutaneous muscle (in the thoracic region between the 6th and 11th rib in both cases) using a Minolta CM-2002 spectrophotometer in the CIEL × a × b × space under D 65, 10° and SCI conditions. Retail cuts were obtained from the right carcass side and classified into four categories following the recommendations given by the Spanish government (M.A.P.A., 1975). The cuts obtained were: filet and strip loin, comprising the Extra category; top round, inside round, rump, knuckle and chuck, First category; shoulder, shin and hind shin, Second category; and flank and clod, Third category. The weights were expressed as a percentage of the right side carcass weight.

Statistical analysis

One-way analysis of variance (breed) was used. Since no significant differences were recorded between European Brown Swiss and American Brown Swiss groups, in none of the studied parameters, the results of both genotypes are shown together as Brown Swiss. The statistical package SPSS 13.0 was used.

RESULTS

Animal performance and slaughter measurements

Animal characteristics and measurements obtained at slaughter are given in Table 1. During the first two years of experiment, no significant effect of breed on daily live-weight gain was observed. However, during the finishing phase (i.e. in the third year), the growth rate of Asturiana de los Valles was significantly lower ($P < 0.05$) than in the other two breeds. Slaughter weight was higher ($P < 0.05$) in BS than in Asturiana de los Valles while the value for Limousin was not significantly different from the slaughter weight of either BS or Asturiana de los Valles. With respect to non-car-

Table 2. Carcass characteristics and carcass classification

Parameters	Asturiana de los Valles	Limousine	Brown Swiss	RSD	*P*
Carcass characteristics					
Hot carcass weight (kg)	499.3^{a}	590.5^{b}	557.5^{b}	52.54	*
Cooling shrinkage (%)	3.20	4.11	2.90	0.425	ns
Dressing percentage (%)	60.31^{a}	64.92^{b}	59.31^{a}	1.705	***
EUROP classification					
Conformation score	3.2^{a}	4.0^{b}	3.0^{a}	0.19	***
Fatness score	2.7^{a}	4.2^{b}	4.8^{b}	0.81	***

***$P < 0.001$; *$P < 0.05$; ns = $P > 0.05$

^{a,b}values with different superscripts indicate significant differences between breeds ($P < 0.05$)

Table 3. pH, carcass linear measurements and carcass colour

Parameters	Asturiana de los Valles	Limousine	Brown Swiss	RSD	*P*
pH 24 *m. semimembranosus*	5.56	5.53	5.51	0.091	ns
pH 24 *m. longissimus lumborum*	5.59	5.79	5.67	0.270	ns
Subcutaneous fat (mm)	12.88[a]	17.3[b]	16.86[b]	3.636	*
Carcass measurements (cm)					
Carcass length	148.1	147.5	152.8	6.765	ns
Hind limb length	91.1	92.4	95.6	2.977	**
Hind limb width	33.5	36.3	33.0	1.849	**
Hind limb perimeter	133.7	140.6	136.3	4.549	*
Subcutaneous fat colour					
*L**	66.4[a]	61.02[b]	62.0b	3.320	*
*b**	13.79[a]	10.26[b]	12.45[c]	1.190	***
Subcutaneous muscle colour					
*L**	38.51	37.19	38.93	2.859	ns
*a**	14.28[a]	12.32[b]	15.65[a]	1.491	**

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; ns = $P > 0.05$

[a,b,c]values with different superscripts indicate significant differences between breeds ($P < 0.05$)

cass parts, the percentages of the majority of them were significantly lower for Limousin. However, the kidney-pelvic fat percentage of BS was significantly higher than in Limousin, the value for Asturiana de los Valles being intermediate and not different from the BS and Asturiana de los Valles percentages.

Hot carcass weight was lowest ($P < 0.05$) in Asturiana de los Valles steers, while no differences between breeds were observed in cooling shrinkage ($P > 0.05$). As regards dressing percentage, the value of Limousin steers was significantly higher ($P < 0.001$) than that of Brown Swiss and Asturiana de los Valles, whereas the difference between the latter breeds was not significant. As shown in Table 2, the highest conformation score corresponded to Limousin, without significant differences between Brown Swiss and Asturiana de los Valles. Great differences between breeds were found in fatness score ($P < 0.001$), the lowest score corresponding to Asturiana de los Valles. In spite of the absence of significant differences in carcass length, the values of length, width and perimeter of hind limbs showed differences between breeds (Table 3). The highest value for hind limb length corresponded to Brown Swiss ($P < 0.01$), while Limousin breed showed the highest values of hind limb width ($P < 0.01$) and hind limb perimeter ($P < 0.05$). With respect to subcutaneous fat colorimetric parameters, Asturiana de los Valles showed the highest L^* and b^* values ($P < 0.05$). In relation to the subcutaneous muscle colour, statistical differences were found only in redness index ($P < 0.01$), providing the lowest values for Limousin.

Lean-weight distribution

As shown in Table 4, significant differences in the percentages of retail cuts were found between breeds. As for the proportions in side weight, no statistical differences were found between breeds in cuts classified as Extra category (filet and strip loin), which are the highest priced cuts. First category cuts, which comprised most of the hind limb cuts, represented a lower percentage in Brown Swiss compared to Limousin ($P < 0.001$), Asturiana de los Valles being at an intermediate position. Regarding the Second category cuts, Limousin breed had the highest percentage and Brown Swiss the lowest, whereas Asturiana de los Valles provided the lowest percentage of cuts classified as Third category ($P < 0.05$). As a consequence, Limousin carcasses provide more saleable meat, considering either absolute value or percentage of side carcass weight.

Table 4. Lean weight distribution in retail cuts

Parameters	Asturiana de los Valles	Limousine	Brown Swiss	RSD	P
Hind quarter (% side carcass weight)					
Filet	1.76	1.59	1.58	0.274	ns
Strip loin	6.98	7.27	7.34	0.521	ns
Top round	5.66[a]	6.00[a]	5.09[b]	0.339	***
Inside round	6.34 [a]	6.63[b]	5.92c	0.241	***
Rump	4.91	4.67	4.70	0.395	ns
Knuckle	4.69[ab]	4.94[a]	4.34[b]	0.366	**
Hind shin	1.45	1.34	1.35	0.134	ns
Fore quarter (% side carcass weight)					
Shoulder	7.72[a]	8.01[b]	7.22[a]	0.509	*
Chuck	10.37[a]	10.91[a]	8.89[b]	0.692	***
Shin	2.69	2.77	2.67	0.330	ns
Clod	4.51	4.83	4.18	0.673	ns
Flank	9.05[a]	10.34[b]	10.72[b]	1.151	*
Retail cuts classified in categories (% side carcass weight)					
Extra category	8.75	8.86	8.92	0.621	ns
First category	30.98[ab]	33.17[a]	28.93[b]	1.118	***
Second category	11.86[ab]	12.13[a]	11.24[b]	0.720	*
Third category	13.57[a]	15.17[b]	14.90[b]	1.090	*
Trim (% carcass weight)	4.14	4.04	3.73	0.484	ns
Saleable meat (kg)	159.0[a]	197.2[b]	170.8[a]	15.99	**
Saleable meat (%)	63.3[a]	66.4[b]	61.1[a]	2.05	***

***$P < 0.001$; **$P < 0.01$; *$P < 0.05$; ns = $P > 0.05$

[a,b]values with different superscripts indicate significant differences between breeds ($P < 0.05$)

DISCUSSION

In the present study, adult steers of three common beef breeds in Spain, with different maturity size, were fed under identical conditions until the same slaughter age. The differences between breeds in growth rate became evident only during the finishing phase, when the highest amount of concentrate was offered, Brown Swiss and Limousin showing the higher growth rate than AS. The absence of the expectable differences between breeds during the growing phase could be related to the fact that feed intake was probably restricted during this phase due to the availability of natural resources, and therefore the animals could not show their growth potential. In support of our results, in an experiment involving steers after sires with a wide range of growth potential under the same feeding strategy, Short et al. (1999) found that differences in growth rate were greater during the finishing phase. However, according to Gregory et al. (1994) and Camfield et al. (1999) when animals are slaughtered as adults, the genetic breed size is also important. In this sense, the lowest live weight at slaughter provided by Asturiana de los Valles was expectable bearing in mind that Asturiana de los Valles is classified as a small frame at maturity (Sañudo et al., 2004; Albertí et al., 2005), and this breed showed lower growth rates during the experimental period. Brown Swiss values are in the range of values reported by Serra et al. (2004), who defined it as a medium-large framed breed, and studies carried out by Camfield et al. (1999) revealed that when slaughtered as adults large framed breeds such as Charolais or Limousin showed the heaviest live weights compared with small framed breeds after feeding periods over 200 days. Therefore, the live weight is largely a result of breed mature size, biological type, or growth type, as in our study.

Data from this experiment were in agreement with those previously reported by Ferrell and Jenkins (1998) and Simoões et al. (2005), who revealed breed differences in the composition of the fifth quarter. In line with our results, Simões et al. (2005) obtained lower values for the percentage of the majority of fifth quarter components studied in Limousin breed. The importance of fifth quarter percentage was reported by Kempster et al. (1982) and Simões et al. (2005), who stated that the parameters such as weight of gut fill, alimentary tract, visceral organs, hide, head and feet could affect not only dressing percentage as growth proceeds, but also explain the differences between breeds in this trait. Our results of fatness grade for Limousin and Asturiana de los Valles are consistent with those obtained by Sañudo et al. (2004), who comparing several European breeds observed significantly lower values in Asturiana de los Valles than in Limousin young bulls. The higher kidney-pelvic fat percentage obtained for Brown Swiss compared to Limousin, together with the absence of statistical differences in fatness score are in line with the results of Micol et al. (1993), Steen and Kilpatrick (1995) and Sañudo et al. (2004), who found out a higher internal fat percentage in dairy and dual-purpose breeds than in meat ones without differences in carcass fat content, which confirms that fat deposition occurs in different breeds in different ways.

Although an excess of carcass fat is generally considered a negative attribute and the commonly used grading systems would penalize those carcasses, high fat content is desirable in the commercialization of beef from adult steers, therefore the fat cover observed in the present study is not considered excessive. In fact, Asturiana de los Valles fatness score could be considered too low, which is a disadvantage in steer production, bearing in mind that, together with the mentioned consumer preferences, meat from adult steers needs a fat cover thick enough to protect the carcasses during the long ageing periods under refrigeration conditions this meat needs to develop desirable meat characteristics. In line with our results, Sañudo et al. (2004) evidenced slight differences in carcass linear measurements between Asturiana de los Valles and Limousin young bulls, e.g. in carcass length, internal depth of breast, limb length or limb thickness, the highest value corresponding to Limousin cattle in all cases. Classification score, carcass and leg measurements reported in the present study for Brown Swiss are within the range of values reported by Serra et al. (2004). A higher dressing percentage in Limousin was expected since this breed showed lower values in the majority of the weights taken from the fifth quarter. A lower dressing percentage was also expected in Brown Swiss, as a dual-purpose breed, taking into account that in dairy cattle the coefficients of growth for non-carcass fat are higher than those for carcass fat (Geay, 1978; Kempster et al., 1982). In addition, Limousin provided a lower fifth quarter percentage than Brown Swiss (27.47 vs. 30.95; $P < 0.05$).

In spite of the absence of differences between breeds in the percentage of Extra category cuts (filet and strip loin), the absolute value (kg) of extra joints was significantly higher for Limousin than for Asturiana de los Valles, Brown Swiss being at an intermediate position (21.73; 26.02 and 24.60 for Asturiana de los Valles, Limousin and Brown Swiss respectively; $P < 0.01$). This is an interesting result bearing in mind that in the commercialization of meat from adult steers rib steaks are the most demanded and valuable joints in specialized restaurants and markets. Although rib steak is, at least nowadays, the most valuable cut in adult steers production, other valuable retail cuts, most of them belonging to the hind quarter, could be commercialised at high prices in the nearest future. In this sense, in spite of the absence of significant differences in slaughter weight, Limousin carcass provided a higher percentage of First category cuts than Brown Swiss, and in general, higher amounts of saleable meat, and for this reason Limousin breed could be more advantageous for steer production. Our results are supported by a study of Listrat et al. (2001) in Charolais and Blonde d'Aquitaine steers slaughtered at 33 months. These authors reported that Blonde d'Aquitaine showed a higher yield for carcass and muscle than Charolais steers without significant differences in slaughter weight.

On the other hand, it is interesting to note that a rustic breed such as Asturiana de los Valles and a dual-purpose breed such as Brown Swiss did not reveal any differences in retail yield. In this sense, Asturiana de los Valles is considered a rustic breed but specialized in meat production as was reported by Sañudo et al. (2004) and Albertí et al. (2005). In spite of the difficulties to make valid comparisons of lean distribution between laboratories in different countries because of differences in the jointing procedure, in general our data are consistent with the general consensus that

continental meat breeds have a higher content of their lean in the hind quarter or pistola or higher priced cuts than dairy or rustic breed types (Keane et al., 1982; Kempster et al., 1982; Keane and Allen, 2002; Chambaz et al., 2003). Our results are consistent with Keane et al. (1982), who found that better conformation of meat breeds was reflected in higher yields of saleable meat, so a significant correlation between conformation score and First category cuts percentage was observed ($r = 0.73$; $P < 0.001$).

Although statistical differences in yellowness and lightness of subcutaneous fat and in subcutaneous muscle redness were found between breeds, all values are within the range of dark-red muscles and yellow fat, which characterizes carcasses from adult steers.

It could be concluded from theses results that comparing three breeds commonly used in the production of adult steers for beef under a production system based on the maximum use of natural resources, Brown Swiss and Limousin breeds had higher live weight at slaughter than Asturiana de los Valles. As regards the carcass value, dressing percentage and retail yield were better in Limousin. On the other hand, owing to consumer preferences and steer characteristics, a high degree of fatness in adult steer carcasses is desirable; therefore Limousin and Brown Swiss could be more suitable for beef production than Asturiana de los Valles. However, further studies on meat quality will provide helpful information in order to evaluate the breeds under that system from a wider point of view.

REFERENCES

Albertí P., Ripio G., Goyache F., Lahoz F., Olleta J.L., Panea B., Sañudo C. (2005): Carcass characterisation of seven Spanish beef breeds slaughtered at two commercial weights. Meat Sci., *71*, 514–521.

Andersen H.A., Oksbjerg N., Young J.F., Therkildsen M. (2005): Feeding and meat quality – a future approach. Meat Sci., *70*, 543–554.

Camfield P.K., Brown A.H. Jr., Johnson Z.B., Brown C.J., Lewis P.K., Rakes L.Y. (1999): Effects of growth type on carcass traits of pasture or feedlot-developed steers. J. Anim. Sci., *77*, 2437–2443.

Chambaz A., Scheeder M.R.L., Kreuzer M., Dufey P.A. (2003): Meat quality of Angus, Simmental, Charolais and Limousin steers compared at the same intramuscular fat content. Meat Sci., *63*, 491–500.

De Boer H., Dumont B.L., Pomeroy R.J., Weniger J.H. (1974): Manual on E.A.A.P. reference methods for the assessment of carcass characteristics in cattle. Livest. Prod. Sci., *1*, 151–164.

Ferrell C.L., Jenkins T.G. (1998): Body composition and energy utilization by steers of diverse genotypes fed a high-concentrate diet during the finishing period: Angus, Belgian Blue, Hereford and Piemontese Sires. J. Anim. Sci., *76*, 637–646.

Geay Y. (1978): Dressing percentage in relation to weight, sex and breed. Curr. Opin. Vet. Med., *2*, 35–46.

Gregory K.E., Cundiff L.V., Koch R.M., Dikeman M.E., Koomaraie M. (1994): Breed effects and retain heterosis for growth, carcass, and meat traits in advanced generations for composite populations of beef cattle. J. Anim. Sci., *47*, 383–388.

Keane M.G., Allen P. (2002): A comparison of Friesian-Holstein, Piemontese × Friesian-Holstein and Romagnola × Friesian-Holstein steers for beef production and carcass traits. Livest. Prod. Sci., *78*, 143–158.

Keane M.G., More O'ferrall G.J., Connolly J. (1982): Growth and carcass composition of Friesian, Limousine × Friesian and Blonde D'Aquitania × Friesian steers. Anim. Prod., *48*, 353–365.

Kempster A.J., Chadwick J.P., Charles D.D. (1982): Estimation of the carcass composition of different cattle breeds and crosses from fatness measurements and visual assessments. J. Agric. Sci., Camb. *106*, 223–237.

Listrat A., Picard B., Jailler R., Collignon H., Peccatte J-R., Micol D., Geay Y., Dozias D. (2001): Grass valorisation and muscular characteristics of Blonde d'Aquitaine steers. Anim. Res., *50*, 105–118.

M.A.P.A. (1975): Normative for retail cuts marketing (in Spanish). Ministry of Agriculture, Fisheries and Food. B.O.E., 165, 15021–15024.

Micol D., Robelin J., Geay Y. (1993): Composition corporelle et caractéristiques biologiques chez les bovines en croissance et à l'engrais. INRA Prod. Anim., *1*, 151–164.

Purchas R.W., Barton R.A., Hunt I.R. (1992): Growth and carcass characteristics of crossbreed steers. New Zeal. J. Agric. Res., *35*, 393–399.

Sañudo C., Panea B., Olleta Monson J.L., Sierra I., Albertí P., Ertbjerg P., Chistiansen M., Gigli S., Failla S., Gaddini A., Hocquette J.F., Jailer R., Nute G.R., Williams J.L. (2004): Carcass quality of several European cattle breeds preliminary results. In: Proceedings of 50th ICoMST, Rome. 516–518.

Serra X., Gil M., Gispert M., Guerrero L., Oliver M.A., Sañudo C., et al. (2004): Characterization of young-

bulls of Bruna dels Pirineus cattle breed (selected from old Brown Swiss) in relation to carcass, meat quality and biochemical traits. Meat Sci., *66*, 425–436.

Short R.E., Grings E.E., MacNeil M.D., Heitschmidt R.K., Williams C.B., Bennett G.L. (1999): Effects if sire growth potential, growing-finishing strategy, and time on feed on performance, composition and efficiency of steers. J. Anim. Sci., *77*, 2406–2417.

Simões J.A., Mira J.F.F., Lemos J.P.C., Mendes I.A. (2005): Dressing percentage and its relationship with some components of the fifth quarter in Portuguese cattle breeds. Livest. Prod. Sci., *96*, 157–163.

Steen R.W.J., Kilpatrick D.J. (1995): Effects of plane of nutrition and slaughter weight of serially slaughtered bulls, steers and heifers of three breed of crosses. Livest. Prod. Sci., *43*, 205–213.

Received: 09–01–2006
Accepted after corrections: 07–10–2006

Corresponding Author

Dra. Ceferina Vieira Aller, Estación Tecnológica de la Carne, Instituto Tecnológico Agrario de Castilla y León, Apdo. 58, 37770 Guijuelo, Spain
Tel. +34 923 59 06 88; fax +34 923 58 03 53; e-mail: vieallce@itacyl.es