

Effect of gender on growth performance, carcass traits and meat quality of calves of Avileña-Negra Ibérica breed

A. Daza^{1*}, A. I. Rey², C. López Carrasco³ and C. J. López-Bote²

¹ *Departamento de Producción Animal. Escuela T.S de Ingenieros Agrónomos. Universidad Politécnica. Ciudad Universitaria. 28040 Madrid. Spain*

² *Departamento de Producción Animal. Facultad de Veterinaria. Universidad Complutense. Ciudad Universitaria. 28040 Madrid. Spain*

³ *CIA "El Dehesón del Encinar". Junta de Comunidades de Castilla-La Mancha. Oropesa. Toledo. Spain*

Abstract

The objective of this experiment was to study the effect of gender on growth performance and carcass and meat quality of calves of Avileña-Negra Ibérica breed. Sixteen calves, eight males and eight females, were used. The calves were fattened under intensive conditions, housed in confinement and fed with the same feed and cereal straw from 230.7 to 478.3 kg. The males grew more than the females (1.390 vs 0.932 kg day⁻¹ respectively). Carcass weight, carcass length, leg length, leg perimeter, carcass and leg compactness, legs, fore-quarters and loins weights and fore-quarters percentage regarding carcass weight were higher ($p < 0.05$) in males than in females. The gender had not significant influence on CIE a^* , b^* , chroma and hue variables but CIE L^* value was significantly ($p < 0.05$) lower in males than in females. The a^* value decreased and b^* and hue values increased with ageing time. The subcutaneous backfat from the females had significantly ($p < 0.05$) higher C14:0, C16:0, C16:1, C18:1 n-9, Σ MUFA and lower C10:0, C18:0, C18:2 n-6, C18:3 n-3, C20:0, C20:3 n-9, C20:4 n-6, C22:5 n-3, Σ n-6, Σ n-3 and Σ PUFA proportions than that from males. It is concluded that the gender has influence on growth performance, carcass traits and fatty acid composition of subcutaneous backfat; gender does not have effect on instrumental colour variables; and meat colour can reach acceptable values for consumers until four days after slaughter.

Additional key words: ageing time; fat colour; muscle colour.

Resumen

Efecto del sexo sobre los resultados productivos, características de la canal y calidad de la carne de terneros de la raza Avileña-Negra Ibérica

El objetivo fue estudiar la influencia del sexo sobre los resultados productivos y calidad de la canal y de la carne de terneros de raza Avileña-Negra Ibérica. Dieciséis terneros, 8 machos y 8 hembras, fueron cebados en estabulación alimentados con el mismo pienso y paja de cereales suministrados desde los 230,7 hasta los 478,3 kg. Los machos crecieron más que las hembras (1,390 vs 0,932 kg día⁻¹ respectivamente). El peso y longitud de la canal, la longitud y perímetro de la pierna, la compacidad de la canal y de la pierna y los pesos de la pierna, cuarto delantero y lomo y el porcentaje de cuarto delantero respecto al peso canal fueron más elevados en los machos. El sexo no tuvo influencia sobre las variables del color del músculo a^* , b^* , chroma y hue pero el valor de L^* fue más bajo ($p < 0,05$) en los machos. El valor de a^* decreció y los de b^* y hue crecieron con el tiempo de maduración de la carne. La grasa dorsal subcutánea de las hembras tuvo proporciones más altas ($p < 0.05$) de C14:0, C16:0, C16:1, C18:1 n-9 y total de monoinsaturados y más bajas de C10:0, C18:0, C18:2 n-6, C18:3 n-3, C20:0, C20:3 n-9, C20:4 n-6, C22:5 n-3, total de n-6, n-3 y poliinsaturados que la de las hembras. Se concluye que el sexo tiene influencia sobre los resultados productivos, características de la canal y composición de ácidos grasos de la grasa dorsal subcutánea; el sexo no tiene efecto sobre las variables del color; y el color de la carne puede tener valores aceptables para los consumidores hasta cuatro días después del sacrificio.

Palabras clave adicionales: color de la grasa; color del músculo; tiempo de maduración.

*Corresponding author: argimiro.daza@upm.es

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Abbreviations used: CW (carcass weight); SEM (standard error of the mean).

Introduction

The Avileña-Negra Ibérica breed is a local breed raised under extensive conditions in the Southwest area of Spain. The most frequent product type is the grazing calf weaned at approximately six months old and live weight around 200-230 kg (Daza, 1998). After weaning calves are generally fattened in confinement and fed with cereal straw and concentrates until they reach around 13-14 months of age with 500 kg of live weight (550 kg the males and 450 kg the females). The calves growth performances and carcass and meat quality obtained during the fattening period depend on factors such as genetic type, gender, initial and slaughter weight, feeding, environment and housing conditions and sanitary status (Daza, 1999). Although there are some experiments that have studied the productive traits and carcass and meat quality of calves of Avileña-Negra Ibérica breed (Sánchez Belda, 1983; Vassallo *et al.*, 1989; Albertí *et al.*, 1997; García & Cruz-Sagredo, 1999), to our knowledge there is not still enough information on the influence of the different variation factors on the performance traits, carcass characteristics and meat quality and, specially, on the fat quality of calves of this breed. Therefore, the objective of the present experiment was to study the effect of gender on growth performance, carcass quality, muscle and fat colour and fatty acid profile of backfat of calves of Avileña-Negra Ibérica breed.

Material and methods

Sixteen calves, eight males and eight females, of Avileña- Negra Ibérica breed from Agricultural Research Center “El Dehesón del Encinar (39° 55' 9" N, 5° 10' 40" O) (Junta de Comunidades de Castilla-La Mancha, Oropesa Toledo, Spain) were used. The calves were weaned at around seven months of age and 230.7±8.6 kg of weight. After weaning, males and females were separated and grouped in independent pens (6.0 m² animal⁻¹) from an indoor housing. The calves were approximately weighed every 30 days. The duration of the fattening period was of 210 and 218 days for the males and females, respectively. During this phase, all animals were fed with the same feed, which composition is presented in Table 1. During all the fattening period feed, cereal straw and water were given *ad libitum*.

The calves were slaughtered at 478.3±15.6 kg live weight. In the slaughterhouse, carcass weight, carcass

Table 1. Ingredients and calculated composition of the experimental diet

| Ingredients (g kg ⁻¹) | |
|--|--------|
| Corn | 400.00 |
| Barley | 287 |
| Fullfat soybean-toasted | 139 |
| Corn gluten | 79.3 |
| Soybean hulls | 30.0 |
| Lard | 30.0 |
| Calcium carbonate | 15.8 |
| Dicalcium phosphate | 1.8 |
| Sodium bicarbonate | 10.0 |
| Sodium chloride | 4.0 |
| Premix | 3.0 |
| Calculated composition ¹ | |
| Metabolizable energy (kcal kg ⁻¹) | 2,945 |
| Crude protein (g kg ⁻¹) | 139.4 |
| Crude fat (g kg ⁻¹) | 58.4 |
| Crude fibre (g kg ⁻¹) | 54.4 |
| Ash (g kg ⁻¹) | 52.6 |
| Vitamin A (IU kg ⁻¹ feed) | 10,000 |
| Vitamin D ₃ (IU kg ⁻¹ feed) | 1,000 |
| Vitamin E (91% alfa-tocopherol) (mg kg ⁻¹ feed) | 25.0 |

¹ FEDNA (2003).

length, thoracic depth, leg length, leg perimeter and leg width were collected 24 h after slaughter, according to the procedures proposed by Sañudo & Campo (1998). The carcass conformation and degree of fatness were estimated according to the carcasses classification criterion of the EEC (1991), by means of a subjective scale that ranged from one to 15 points. The carcasses were divided in four large joints: leg, fore-quarter, loin (sirloin and high and low loin) and flank (flank and lower area of the ribs). The carcass joints were weighed on a balance of precision. A piece of the *longissimus dorsi* muscle was collected for muscle and fat colour analysis and to analyze the fatty acid composition of subcutaneous backfat. Samples for fatty acid analysis were vacuum packed and stored at -20°C until analysis. A 2-cm thick sample was displayed on trays and maintained at 4°C for colour measurement. Fat colour was measured one day after slaughtered. Muscle colour was evaluated, one, four and eight days after slaughter, by means of a chromameter [CM 2002, Minolta, Camera, Osaka, Japan) previously calibrated against a white tile, according to manufacturer recommendations (CIE, 1976)]. The average of three random readings was used to measure lightness (L^*), redness (a^*) and yellowness (b^*). Additionally, chroma and hue angle were calcu-

lated as chroma = $(a^{*2} + b^{*2})^{0.5}$ and hue = $57.29 \arctg(b^*/a^*)$ respectively (Albertí *et al.*, 2011). Backfat colour was evaluated one day after slaughter.

Lipids from backfat were extracted by the procedure proposed by Bligh & Dyer (1959). Fat extracts were methylated in the presence of sulphuric acid and identified by gas chromatography as described elsewhere (López Bote *et al.*, 1997) using a 6890 Hewlett Packard (Avondale, PA, USA) gas chromatograph equipped with an automatic injector, a flame ionisation detector and a capillary column (HP-Innowax, Agilent Technologies G_{mhb} 30 m × 0.32 mm i.d and 0.25 µm cross-linked polyethylene glycol). A temperature program of 170 to 245°C was used; the injector and detector were maintained at 250°C and a split ratio of 1:50 was used. The carrier gas (helium) flow rate was 3 mL min⁻¹.

The data obtained for performance were studied by means of covariance analysis that considered the gender as fixed effect and the calves' initial weight as covariate. The carcass characteristics were studied by means of variance analysis (gender as fixed effect), although a covariance analysis that consider the slaughter weight as covariate was also carried out. The muscle colour was studied by means of variance analysis that included the gender and ageing time as fixed effects, while to study fat colour only the gender was considered as variation factor. The fatty acid composition of subcutaneous backfat was studied by means of variance analysis that included the gender as fixed effect and carcass weight and fatness degree as covariates. The covariates were considered significant when $p < 0.05$, removing them from

statistical models when $p > 0.05$. In addition, simple and multiple regression and correlation analyses were carried out in order to estimate the relationships between the carcass joints weight and other carcass characteristics, and the instrumental colour variables and the ageing time. All analysis were carried out by means of the statistical package SAS (1999).

Results and discussion

The performance results are shown in Table 2. In accordance with Sánchez Belda (1983, 1984) in the current experiment the average daily gain during the experimental period was higher in males than in females (1.39 vs. 0.93 kg). The calves initial weight had significant ($p < 0.05$) effect on slaughter weight but did not affect to the average daily gain. The slaughter weight increased 0.58 kg per each kilogram of initial weight increase.

It is interesting to note that, at the beginning of the fattening period (0-13 days), the average daily gains of males and females were very low. This was due to that calves consumed small quantities of feed and straw during this first phase of fattening period because of the weaning stress (Neumann, 1989). Also, it is of interest to note that at the end of the fattening period (from the day 136 to the slaughter) males, as well as females, reduced the average daily gain, which agrees with the results found by Sánchez-Arjona (2001) in Morucha breed calves. This is because as the calves weight increased the feed conversion efficiency impaired due to

Table 2. Growing performance according to gender

| Variable | Males | Females | SEM ¹ | <i>p</i> value gender | <i>p</i> initial weight (covariate) |
|---------------------------------------|-------|---------|------------------|-----------------------|-------------------------------------|
| Initial weight (kg) | 237.1 | 224.3 | 8.640 | 0.31 | – |
| ADG ² (0-13 days) (kg) | 0.096 | 0.115 | 0.157 | 0.93 | 0.34 |
| ADG (13-50 days) (kg) | 1.594 | 1.209 | 0.063 | 0.001 | 0.45 |
| ADG (50-76 days) (kg) | 1.625 | 1.183 | 0.068 | 0.001 | 0.70 |
| ADG (76-106 days) (kg) | 1.887 | 1.091 | 0.066 | 0.001 | 0.52 |
| ADG (106-136 days) (kg) | 1.554 | 1.395 | 0.105 | 0.30 | 0.23 |
| ADG (136-163 days) (kg) | 1.065 | 0.560 | 0.163 | 0.046 | 0.54 |
| ADG (163-185 days) (kg) | 1.483 | 0.858 | 0.130 | 0.004 | 0.65 |
| ADG (185-210 days) ³ (kg) | 0.99 | 0.534 | 0.105 | 0.007 | 0.19 |
| ADG (0-210 days) ⁴ (kg) | 1.390 | 0.932 | 0.054 | 0.0001 | 0.58 |
| Weight at slaughter ⁵ (kg) | 521.2 | 435.2 | 12.340 | 0.007 | 0.001 |
| Weight at slaughter ⁶ (kg) | 529 | 427.5 | 15.6 | 0.0004 | – |

¹ SEM = standard error of the mean. ² ADG = average daily gain (kg). ³ 185-218 days for the females.

⁴ 0-218 days for the females. ⁵ are least square means. ⁶ are arithmetic means.

the increase of the deposited fat in tissues (Neumann, 1989; Albertí, 1998). During the total fattening period males consumed 1,510 and 205 kg of feed and straw per animal respectively, whereas the female's consumption was 1,060 and 149 kg. The slaughter weights of the males and females were 529.0 and 427.5 kg respectively. Therefore, the feed conversion efficiency was 5.17 and 5.21 kg kg⁻¹ for males and females respectively. Albertí *et al.* (1997) found a feed conversion efficiency of 4.9 kg kg⁻¹ for males of Avileña breed that were fattened between 252.6 and 451.5 kg. The feed conversion efficiency was higher in our experiment because the slaughter weight of the males was greater than those data reported by Albertí *et al.* (1997).

The results of variance analysis (without the slaughter weight as covariate) for carcass traits by gender and the slaughter weight effect as covariate on carcass characteristic are presented in Table 3. The carcass characteristics values found in the current study are in agreement with those found by García & Cruz-Sagredo (1999) in Avileña breed calves. Carcass weight, carcass length, leg length, leg perimeter, carcass and leg compactness, legs, fore-quarters and loins weights and fore-quarters percentage regarding carcass weight were higher ($p < 0.05$) in males than in females. Also Sueiro (1994) detected less

carcass length in females of Rubia Gallega breed. Moreover, the males tended ($p < 0.10$) to have a leg width and flank weight higher than the females. Nevertheless, legs and flank percentages regarding carcass weight values were significantly ($p < 0.05$) higher in females than in males, and the females tended ($p < 0.10$) to show conformation values higher than the males. No significant ($p > 0.05$) differences were observed between males and females for the variables carcass yield, thorax depth, leg width, leg length⁻¹ ratio, loins percentage regarding carcass weight and fatness degree. The slaughter weight as covariate (Table 3) had a significant ($p < 0.05$) effect on the most of the carcass characteristics studied. However, no significant ($p > 0.05$) effect on the variables carcass yield, leg width and leg width \times leg length⁻¹ ratio was observed, which agrees with data reported by Panea *et al.* (1999) in Pirenaica breed calves. The slaughter weight had not significant influence ($p > 0.05$) on the legs, fore-quarters, loins and flank percentages respect to carcass weight.

In order to quantify the relationships between the weight of carcass major joints and the independent variables carcass weight (CW) and other easily measurable carcass characteristics, simple and multiple regression equations were calculated (Table 4). The relationships between the legs, fore-quarters and loins weights and

Table 3. Effect of gender on major carcass characteristics

| Variable | Males | Females | SEM ¹ | <i>p</i> value | <i>p</i> value of slaughter weight as covariate |
|---|-------|---------|------------------|----------------|---|
| Carcass weight (kg) | 281.9 | 223.8 | 7.72 | 0.0001 | 0.0001 |
| Carcass yield (%) | 53.3 | 52.5 | 0.63 | 0.35 | 0.80 |
| Carcass length (cm) | 135.8 | 126.4 | 1.06 | 0.0001 | 0.0002 |
| Thorax depth (cm) | 62.2 | 61.7 | 0.85 | 0.17 | 0.013 |
| Leg length (cm) | 82.2 | 78.1 | 0.86 | 0.004 | 0.007 |
| Leg perimeter (cm) | 108.2 | 102.7 | 0.89 | 0.0006 | 0.0002 |
| Leg width (cm) | 43.9 | 42.8 | 0.45 | 0.083 | 0.48 |
| Carcass compactness (kg cm ⁻¹) ² | 2.1 | 1.8 | 0.046 | 0.0004 | 0.0001 |
| Leg compactness (kg cm ⁻¹) ³ | 1.1 | 0.94 | 0.025 | 0.001 | 0.0001 |
| Leg width \times leg length ⁻¹ | 0.54 | 0.56 | 0.007 | 0.21 | 0.19 |
| Legs weight (kg) | 89.7 | 73.9 | 2.52 | 0.0006 | 0.0001 |
| Fore-quarter weight (kg) | 101.2 | 74.3 | 2.62 | 0.0001 | 0.0004 |
| Loins weight (kg) | 49.9 | 38.8 | 1.42 | 0.0001 | 0.0001 |
| Flank weight (kg) | 41.0 | 36.6 | 1.80 | 0.10 | 0.0002 |
| % Legs | 31.8 | 33.1 | 0.33 | 0.020 | 0.83 |
| % Fore-quarter | 35.9 | 33.3 | 0.41 | 0.0005 | 0.13 |
| % Loins | 17.7 | 17.3 | 0.19 | 0.19 | 0.56 |
| % Flank | 14.5 | 16.3 | 0.40 | 0.0075 | 0.15 |
| Conformation | 7.1 | 7.9 | 0.26 | 0.063 | 0.0001 |
| Fatness degree | 8.0 | 7.9 | 0.36 | 0.81 | 0.001 |

¹ SEM = standard error of the mean. ² carcass weight/carcass length. ³ leg weight/leg length.

Table 4. Relationships between the weight (kg) and percentage of the carcass major joints and the carcass weight (CW in kg) and carcass conformation (C)

| Regression equation | (R ²) ¹ | RSD ² | p value |
|---|--------------------------------|------------------|---------|
| Legs weight = 10.05 + 0.28 CW | 0.95 | 2.41 | 0.0001 |
| Fore-quarters weight = -16.19 + 0.41 CW | 0.94 | 3.99 | 0.0001 |
| Loins weight = -2.59 + 0.18 CW | 0.96 | 1.42 | 0.0001 |
| Flank weight = 68.93 - 7,459 CW ⁻¹ | 0.66 | 3.29 | 0.0001 |
| Flank weight = -7.57 + 0.11 CW + 2.30 C | 0.76 | 2.84 | 0.0001 |
| Legs (%) = 28.25 + 1,040.2 CW ⁻¹ | 0.31 | 0.95 | 0.025 |
| Fore-quarters (%) = 28.24 + 0.025 CW | 0.28 | 1.53 | 0.036 |
| Fore-quarters (%) = 36.25 + 0.027 CW - 1.13 C | 0.56 | 1.24 | 0.013 |
| Loins (%) = 16.46 + 0.0042 CW | 0.07 | 0.58 | 0.31 |
| Flank (%) = 18.69 - 0.013 CW | 0.11 | 1.30 | 0.21 |
| Flank (%) = 8.87 + 0.87 C | 0.25 | 1.27 | 0.048 |

¹R² = determination coefficient. ²RSD = residual standard deviation.

CW adjusted to linear functions, whereas the relationship between flank weight adjusted to an inverse function of type $y = a + bx^{-1}$. CW accounted for 95, 94, 96 and 66% of the variations in legs, fore-quarter, loins and flank weight respectively. Nevertheless, the addition to the regression equation that related flank weight with carcass weight of the independent variable conformation (C) increased the determination coefficient (R²) from 0.66 to 0.76. It means that the variables CW and C, jointly, accounted for 76% of the variation in flank weight. However CW only accounted for 31, 28, 7 and 11% of the variations in legs, fore-quarters, loins and flank percentages regarding carcass weight respectively, while only C accounted for 25% of the variation in flank percentage and CW and C, jointly, accounted for 56% of the variation in fore-quarters percentage.

The effects of gender and ageing time on muscle instrumental colour are shown in Table 5. It is considered that the males have less bright and more pigmented meat

than the females due to their higher physical activity and mioglobine content (Lawrie, 1977). In this experiment the gender had not significant influence on CIE a^* , b^* chroma and hue variables of muscle colour, but L^* value was significantly ($p < 0.05$) lower in males than in females. Monserrat *et al.* (2001), in calves of Rubia Gallega breed finished in confinement under intensive conditions, did not find effect of gender on muscle colour. The ageing time had significant effect on muscle colour. The a^* value observed eight days after slaughter was lower than those found one day after slaughter and three days later, while b^* value found one day after slaughter was lower than those observed three and seven days afterwards. Carballo *et al.* (2001) and Onega *et al.* (2001) observed an increase of b^* value with the ageing time, but the a^* value not varied. The gender had not effect on chroma and hue values, which agrees with the data from Monserrat *et al.* (2001). The hue value increased with the ageing time, which is related with meat

Table 5. Influence of gender and ageing time on the variables of muscle instrumental color

| Variable | Gender (G) | | | Ageing time (AT) (days after slaughter) | | | | | | |
|---------------------|------------|--------|------------------|---|--------------------|--------------------|------------------|--------------|---------------|---------------------|
| | Male | Female | SEM ¹ | 1 | 4 | 8 | SEM ¹ | G p value | AT p value | (G × AT) p value |
| L^* | 40.50 | 42.50 | 0.57 | 41.59 | 40.63 | 42.28 | 0.70 | 0.018 | 0.26 | 0.24 |
| a^* | 17.55 | 17.71 | 0.33 | 18.41 ^a | 18.93 ^a | 15.55 ^b | 0.41 | 0.873 | 0.0001 | 0.28 |
| b^* | 7.27 | 7.61 | 0.19 | 3.29 ^a | 9.86 ^b | 9.18 ^b | 0.23 | 0.21 | 0.0001 | 0.11 |
| chroma ² | 19.53 | 19.23 | 0.35 | 18.72 ^a | 21.36 ^b | 18.07 ^a | 0.43 | 0.55 | 0.0001 | 0.14 |
| hue ³ | 22.50 | 22.92 | 0.46 | 10.03 ^a | 27.50 ^b | 30.58 ^c | 0.57 | 0.52 | 0.0001 | 0.15 |

¹ SEM = standard error of the mean. ² chroma = $(a^{*2} + b^{*2})^{0.5}$. ³ hue = $57.29 \text{ arc tag } (b^*/a^*)$. Means with different superscripts are significantly different ($p < 0.05$).

colour losses and is in accordance with the a^* values observed. These results may indicate that meat colour could reach acceptable values for consumers until four days after slaughter. Albertí *et al.* (2011) also found a hue value increase with ageing time in Gasconne breed. The interaction *gender* \times *ageing time* was not significant for all the colour instrumental variables.

To clarify results Pearson correlation coefficients were calculated between colour variables and ageing time (Table 6). The correlation coefficients for L^* and chroma and ageing time were not significant ($p > 0.05$), but the coefficient between a^* and ageing time was negative and significant ($p < 0.05$), whereas correlation coefficients for b^* and hue and ageing time were positive and significant ($p < 0.05$).

The gender had not significant effect on subcutaneous backfat L^* and b^* values (data not presented), but the males had higher ($p < 0.05$) a^* value than the females (8.29 vs. 6.44, SEM = 0.58), which is not in concordance with data from Monserrat *et al.* (2001).

In Table 7 the influence of gender on fatty acid profile of subcutaneous backfat is presented. The subcutaneous backfat from the females had significantly ($p < 0.05$) higher C14:0, C16:0, C16:1, C18:1 n-9, Σ MUFA and lower C10:0, C18:0, C18:2 n-6, C18:3 n-3, C20:0, C20:3 n-9, C20:4 n-6, C22:5 n-3, Σ n-6, Σ n-3 and Σ PUFA proportions than that from the males. The C18:1/C18:0, Σ MUFA/ Σ SFA and Σ SFA/ Σ PUFA ratios were higher ($p < 0.05$) in females than in males, while the Σ n-6/ Σ n-3 ratio was higher ($p < 0.05$) in males than in females. Calvo *et al.* (1999) found higher C14:0, C16:0, C16:1, C18:1 n-9 and lower C18:0 and C18:2 n-6 proportions in intramuscular fat of *longissimus thoracis* muscle from females than of males of Rubia Gallega breed, and Moreno *et al.* (2006) also observed that C14:0, C16:0 and C18:1 n-9 and Σ MUFA contents in intramuscular fat were higher in females than in males of Rubia Gallega breed, but no significant effect of gender was detected for Σ PUFA content. Also Waldman *et*

Table 6. Pearson correlation coefficients between color instrumental variables and ageing time

| Variable | n ¹ | R values ² | p values |
|----------|----------------|-----------------------|----------|
| L^* | 48 | 0.11 | 0.45 |
| a^* | 48 | -0.57 | 0.0001 |
| b^* | 48 | 0.73 | 0.0001 |
| chroma | 48 | -0.17 | 0.24 |
| hue | 48 | 0.87 | 0.0001 |

¹ n = number of observations pairs. ² R = correlation coefficient.

Table 7. Effect of gender on fatty acid profile (%) of subcutaneous backfat

| Fatty acid | Males | Females | SEM ¹ | p value |
|-----------------------------|-------|---------|------------------|---------|
| C10:0 | 0.44 | 0.17 | 0.052 | 0.0027 |
| C12:0 | 0.044 | 0.044 | 0.0035 | 0.99 |
| C14:0 | 1.97 | 2.39 | 0.12 | 0.025 |
| C15:1 | 0.029 | 0.020 | 0.0045 | 0.19 |
| C16:0 | 24.01 | 26.56 | 0.61 | 0.011 |
| C16:1 | 2.29 | 2.66 | 0.090 | 0.013 |
| C17:0 | 0.83 | 0.79 | 0.040 | 0.49 |
| C17:1 | 0.42 | 0.44 | 0.019 | 0.54 |
| C18:0 | 20.30 | 18.10 | 0.54 | 0.013 |
| C18:1 n-9 | 38.03 | 42.51 | 0.77 | 0.0011 |
| C18:2 n-6 | 7.97 | 3.84 | 0.67 | 0.0007 |
| C18:3 n-3 | 0.50 | 0.31 | 0.032 | 0.0014 |
| C18:4 n-3 | 0.31 | 0.28 | 0.014 | 0.12 |
| C20:0 | 0.16 | 0.14 | 0.0061 | 0.017 |
| C20:1 | 0.21 | 0.17 | 0.020 | 0.21 |
| C20:3 n-9 | 0.065 | 0.034 | 0.0095 | 0.036 |
| C20:4 n-6 | 1.66 | 1.027 | 0.18 | 0.031 |
| C20:5 n-3 | 0.24 | 0.17 | 0.026 | 0.11 |
| C22:5 n-3 | 0.47 | 0.30 | 0.051 | 0.033 |
| C22:6 n-3 | 0.039 | 0.022 | 0.0073 | 0.14 |
| Σ SFA ² | 47.76 | 48.20 | 0.90 | 0.74 |
| Σ MUFA ² | 40.98 | 45.80 | 0.81 | 0.0008 |
| Σ PUFA ² | 11.26 | 6.00 | 0.96 | 0.0018 |
| Σ n-6 ² | 9.63 | 4.87 | 0.85 | 0.0015 |
| Σ n-3 ² | 1.56 | 1.10 | 0.11 | 0.008 |
| C16:1/C16:0 | 0.095 | 0.10 | 0.0034 | 0.34 |
| C18:1/C18:0 | 1.88 | 2.38 | 0.094 | 0.0022 |
| Σ MUFA/ Σ SFA | 0.86 | 0.96 | 0.027 | 0.025 |
| Σ n-6/ Σ n-3 | 6.03 | 4.38 | 0.23 | 0.0002 |
| Σ SFA/ Σ PUFA | 4.79 | 8.67 | 0.83 | 0.0053 |

¹ SEM = standard error of mean. ² Σ SFA, Σ MUFA, Σ PUFA, Σ n-6, Σ n-3 = sum of all saturated, monounsaturated, polyunsaturated, n-6 and n-3 fatty acids, respectively.

al. (1968), Terrel *et al.* (1969), Marcello *et al.* (1970) and Zembayashi *et al.* (1995), comparing males and females, found higher C18:1 n-9 and MUFA concentrations in subcutaneous fat from females. Westerling & Hedrick (1979) observed that samples of combined subcutaneous and intramuscular fat deposits from steers had more C18:2 n-3 and C18:3 n-3 acids than did fat from heifers, but no differences were detected between the total percentages of saturated and unsaturated fatty acids.

The higher values of the desaturation indexes C18:1/C18:0 and Σ MUFA/ Σ SFA observed in the subcutaneous fat from females suggests that the delta-9-desaturase enzyme activity was higher in females than in males. However, high Σ SFA/ Σ PUFA and Σ n-6/ Σ n-3 ratios in beef fat have been considered harmful for

health (Moloney *et al.*, 2001). In the current study the Σ SFA/ Σ PUFA ratio was higher in females than in males, although occurred the contrary effect for the Σ n-6/ Σ n-3 ratio. Since in the current experiment C18:1 n-9 and Σ MUFA proportions were higher in females than in males while Σ n-6/ Σ n-3 ratio was lower, subcutaneous fat from females would be healthier than that from males. Wood & Enser (1997) also reported that these variables would be good indicators of fat quality.

In the present experiment the carcass weight and fatness degree had not significant ($p > 0.05$) influence on fatty acids proportions of subcutaneous backfat. However, some studies have considered that an increase in beef fat led to an increase in Σ MUFA and decrease in Σ PUFA (Moreno *et al.*, 2006), although according to Prior *et al.* (1983) the manipulation of sex hormone status of living cattle influenced lipid metabolism in the adipose tissue, and sex differences in the fatty acid composition are known to be associated with hormonal changes and their possible effect on enzymatic systems.

It is concluded that the gender has influence on growth performance, carcass traits and fatty acid composition of subcutaneous backfat of Avileña-Negra Ibérica calves fattened under intensive conditions; gender does not have effect on instrumental colour variables; and meat colour can reach acceptable values for consumers until four days after slaughter.

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