Breed effect between Mos rooster (Galician indigenous breed) and Sasso T-44 line and finishing feed effect of commercial fodder or corn.

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Abstract

The aim of this research was to study the Mos rooster breed growth performance, carcass and meat quality. Nowadays, Mos rooster is the only autochthonous breed of Galicia (NW Spain) included in the Official Catalogue of Cattle's Breeds of Spain as being in danger of extinction. However, the recent interest, both public and private, that the recovery has aroused means that we can count on differentiated product that requires appropriate studies to compete with other breeds on the market. The breed effect (Mos *vs.* Sasso T-44) and finishing feed in the last month (fodder vs. corn) on animal growth, carcass characterises, meat quality, fatty and amino acid profile were studied. Finishing feeding did not affect growth parameters in the two genotypes of rooster tested ($P>0.05$). Nonetheless, the comparison between the two types of roosters led to significant differences in growth parameters ($P<0.05$). Regarding carcass characteristic, no significant influences of finishing feeding treatment ($P>0.05$) were found and as expected, carcass weight clearly differed between genotypes, due to the lower growth rate of Mos roosters. However, drumstick, thigh and wing percentages were greater in Mos breed, than in hybrid line. In colour instrumental traits, roosters feeding with corn showed breast with a significant ($P<0.001$) higher L* and a* and b* lesser than cocks feeding with commercial fodder. Values of shear force were less than 2 kg for both genotypes, thus it can be classified as "very tender" meat. Birds finishing with corn increased significantly ($P<0.001$) the PUFA content in the breast, obtaining in the Mos breed a P/S ratio of 0.73. The amino acid profile of the indigenous breed breast was not similar to that of the commercial strain breast, besides finishing feeding treatment had more impact on amino acid profile affecting the majority of amino acids.

Keywords: Mos, growth curve, Carcass quality, Meat quality, Sensorial and textural properties

1. Introduction

The Mos rooster is an autochthonous breed of Galicia (NW Spain) that at the beginning of last century had an important prestige, suffering from this moment a continuous decrease caused by the introduction of improved breeds and their crosses. The alarming situation in which the breed was in the second half of the 20th century, close to disappearing, led to Galician government to take some actions, such as implementing a recovery and conservation program. Nowadays, Mos is the only poultry native breed of Galicia included in the Official Catalogue of Cattle's Breeds of Spain as being in danger of extinction (R.D. 2129/2008). Mos breed has been promoted by a breeder's association since 2001 (Mos Hen Breed Poultry Association-AVIMOS) as well as a Record of Births of Stud-Book (DOGA, 2001) so their number has grown in recent years with about 6980 sows in 2010 (MARM, 2010). This breed is known for its great rusticity which allows it to adapt to extensive production system. It has been established, that many factors are modified in extensive systems compared to intensive, such as climatic variations and physical activity for animals, which may influence carcass, physicochemical meat traits and consequently meat quality.

In the development of local breeds and their typical products it is advisable to evaluate the role and values of their traditional farming systems. Widespread societal concerns about animal welfare (Sundrum, 2001) and environmental issues caused by intensive farming are primary factors contributing to an emerging interest in the diversification of poultry industry towards more extensive and sustainable production systems. The use of local breeds as an alternative poultry production system has important advantages, as

these breeds are closely related to the environment and they help to maintain biodiversity and sustainable agricultural production, especially in depressed areas.

In addition, several studies have observed that consumers have grown somewhat tired of broiler meat, because of their scarce taste. Furthermore, the higher income of the population have resulted in consumers becoming more demanding in the choice of products, seeking good quality and specifying what they prefer, since local chicken breeds has good acceptation in a gourmet niche. Previous studies confirm that carcass and meat quality can be influenced by individual factors such as diet (Fris Jensen, 1997), age/live weight (Touraille et al., 1981) and breed or genotype (Jaturasitha, 2008; Wattanachant, 2004). However, information about this breed is very scarce and only previous studies on chemical composition and physico-chemical properties of meat from castrated roosters (Sanchez, et al., 2005; Diaz, et al., 2010) and on fatty acid profile of intramuscular fat of breast and drumstick (Rodriguez, 2010) have been realised on this breed, but no more knowledge is published in the literature.

Hence, there are no studies about production performance, carcass characteristics, meat quality or sensorial properties in entire Mos roosters; the aim of this study is to describe the aforementioned parameters.

2. Materials and Methods

2.1. Experimental design, animal management and sample collection.

A total of 80 roosters (n=30 of Sasso T-44 line and n=50 of Mos breed) were used. They were separated by breed were and allocated to two feeding treatment groups (concentrate and corn). Each feeding treatment group consisted of 15 and 25 roosters, for Sasso T-44 line and Mos breed, respectively. Birds were fed with a standard compound feed (ME: 13.19 MJ/kg, CP: 230 g/kg as fed basis, for more details see Table

1), provided by Piensos Biona (Lalin, Spain). Table 1 shows the chemical composition and fatty acid profile of commercial fodder. Intakes of compound feed and live weight (LW) of birds in all treatment groups were recorded biweekly during the 6 month of experimental period. All birds were slaughtered in an accredited abattoir at 6 months by manual exsanguination, plucked and eviscerated. Carcasses were refrigerated for 24 hours at 4 ºC to determine carcass weight (CW), dressing percentage (DP) and main commercial cuts. From the refrigerated carcasses head, neck, legs, edible viscera (heart, liver, gizzard), and fat (perivisceral, perineal and abdominal) were removed to obtain the joints: drumstick, thigh, wing and breast. The *pectoralis major* and *peroneous longus* muscles were excised from breast and drumstick for analysis. Breast was used to measure pH, colour parameters, water holding capacity and textural traits, whereas drumstick was minced and used for chemical composition determinations.

2.2. Analytical Methods

2.2.1. pH, colour, heme-iron content and chemical composition

The pH, colour and chemical composition of the samples were measured according to describe by Lorenzo et al. (2011), whereas heme-iron content was measured following Franco et al. (2011).

2.2.2. WHC and texture analysis

Breast cuts were cooked placing vacuum package bags in a water bath with automatic temperature control (JP Selecta, Precisdg, Barcelona, Spain) until they reached an internal temperature of 70 ºC, controlled by thermocouples type K (Comark, PK23M, UK), connected to a data logger (Comark Dilligence EVG, N3014, UK). After cooking, samples were cooled in a circulatory water bath set at 18 ºC during a period of 30 min

and the percentage cooking loss was recorded. All samples were cut perpendicular to the muscle fibre direction at a crosshead speed of 3.33 mm/s in a texture Analyzer (TA.XT.plus of Stable Micro Systems, Vienna Court, UK).

Four meat pieces of 1×1×2.5 cm (height × width × length) were removed parallel to the muscle fibre direction and were completely cut using a Warner-Braztler (WB) shear blade with a triangular slot cutting edge (1 mm of thickness). Maximum shear force (Møller, 1980), shear firmness (Brady and Hunecke, 1985) and total necessary work performed to cut the sample were obtained.

The water-holding capacity (WHC) was measured by cooking loss (*CL*). The *CL* was evaluated by cooking breast (*pectoralis major* muscle*)* as described in the texture analysis. The *CL* was calculated by measuring the difference in weight between the cooked and raw samples as follows:

$$CL = \frac{(\text{weight loss})}{(\text{initial fresh meat weight})} \times 100 \qquad [1]$$

2.2.3. Analysis of fatty acid methyl esters

Before analysis, intramuscular fat was extracted from 5 g of ground meat sample according to Folch et al. (1957). Lipid extracts were evaporated to dryness under vacuum at 35 °C and stored at -80 °C until analysis by preparation of fatty acid methyl esters (FAME´s). Lipids were transesterified with a solution of boron trifluoride (14%) in methanol, as described by Carreau and Dubacq (1978). Fifty milligrams of the extracted lipids were esterified and the FAME´s were stored at -80 °C until chromatographic analysis.

Separation and quantification of the fatty acid methyl esters was carried out using a gas chromatograph (GC, Agilent 6890N, Agilent Technologies Spain, S.L., Madrid, Spain)

equipped with a flame ionization detector and an automatic sample injector HP 7683, and using a Supelco SPTM-2560 fused silica capillary column (100 m, 0.25 mm i.d., 0.2 μm film thickness, Supelco Inc, Bellefonte, PA, USA). The chromatographic conditions were as follows: initial column temperature 120 °C maintaining this temperature for 5 min, programmed to increase at a rate of 5 °C/min up to 200 °C maintaining this temperature for 2 min, then at 1 °C/min up to 240 °C maintaining this temperature for 5 min. The injector and detector were maintained at 260 and 280 °C respectively. Helium was used as carrier gas at a constant flow-rate of 1.1 mL/min, with the column head pressure set at 35.56 psi. The split ratio was 1:50, and 1 μL of solution was injected. Nonanoic acid methyl ester (C9:0 ME) at 0.3 mg/mL was used as internal standard. Individual fatty acid methyl ester, were identified by comparing their retention times with those of authenticated standards. Fatty acids were expressed as a percentage of total fatty acids identified.

2.2.4. Protein amino acid profile.

The hydrolysis of the protein, derivatization and identification of hydrolizated amino acid was carried out following procedure described by Franco et al. (2010).

2.2.5. Sensory analysis.

The taste panel evaluation was conducted with eight panellists selected from the Meat Technology Centre of Galicia. Panellists were trained according to methodology proposed by UNE regulations [UNE 87-024-95 (AENOR, 1995)] over 3 months with the attributes and the scale to be used. The samples were individually labelled with 3-digit random numbers. Ten sensory traits of drumstick fresh meat were considered: skin colour, skin transparency, darkness lean, fat firmness, intensity odour, rancidity odour

and liver odour, while for cooked meat were taste intensity, rancidity taste, liver taste, hardness, juiciness, pastosity and fibrousness, following methodology proposed by UNE regulations [UNE 87-013-96 (AENOR, 1996a), UNE 87-017-92 (AENOR, 1992), UNE 87-025-96 (AENOR, 1996b), UNE 87-026-00 (AENOR, 2000)]. The intensity of every attribute was expressed on a structured scale from 0 (very low) to 9 (very high) in two sessions, a specific session for this samples and the evaluation session. During sensory evaluation, the panellists were situated in private cubicle illuminated with red light, according to UNE regulations [UNE 87-001-94 (AENOR, 1994), UNE 87-004-79 (AENOR, 1979)]. The panellists were given water to clean the palate and remove residual flavours at the beginning of the session and between samples.

2.2.6. Animal growth

The mathematical model used to describe the sigmoid profiles of animal growth was the logistic equation (Vázquez et al., 2004; Rial et al., 2011):

$$G = \frac{G_m}{1+\exp\left[\mu_m\left(\tau - t\right)\right]} \qquad [2]$$

A reparameterised form of this model was also applied to obtain other interesting kinetic parameters (Vázquez and Murado, 2008):

$$G = \frac{G_m}{1+\exp\left[2+\frac{4v_m}{P_m}\left(\lambda - t\right)\right]} \qquad [3]$$

where, G is the growth of roosters (kg), G_m is the maximum growth of roosters (kg), t is the age of growth (weeks), μ_m is the specific maximum rate of growth (weeks^{-1}), τ is the time required to reach the half of the maximum growth (weeks), v_m is the maximum rate of growth (kg weeks^{-1}) and λ is the lag phase (weeks).

The relation between feed efficiency (*FE*) and age was modelled by linear equations being b (kg of food consumed kg^{-1} of rooster weeks^{-1}) the corresponding slope.

2.2.7. Numerical methods and statistical analysis

Fitting procedures and parametric estimations calculated from the results were carried out by minimisation of the sum of quadratic differences between observed and model-predicted values, using the non linear least-squares (quasi-Newton) method provided by the macro '*Solver*' of the Microsoft Excel XP spreadsheet. Subsequently, confidence intervals from the parametric estimates (Student's t test), consistence of mathematical models (Fisher's F test) and residual analysis (Durbin-Watson test) were evaluated using DataFit 9 (Oakdale Engineering, Oakdale, PA, USA).

For the statistical analysis of the results of carcass and meat quality an analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the SPSS package (SPSS 15.0, Chicago, IL, USA) was performed for all variables considered in the study. Fixed effect of breed and finishing feed was included in the model. The model used was:

$$Y_{ij} = \mu + B_i + F_j + \varepsilon_{ij} \qquad [4]$$

where:

Y_{ij} is the observation of dependent variables, μ is the overall mean, B_i is the effect of breed, F_j is the effect finishing feed, and ε_{ij} is the residual random error associated with the observation. Interaction $B \times F$ was included in the model, only when significance

was showed. Correlations between variables (P<0.05) were determined by correlation analyses using the Pearson´s linear correlation coefficient with SPSS 15.0 for Windows (SPSS 15.0, Chicago, IL, USA) software package.

3. Results and Discussion

3.1. Feed efficiency and growth curves

Figure 1 shows the kinetics of roosters that were sacrificed at 24 weeks with the corresponding fits to the equation [3] and the time-course of *FE* fitted to a linear equation. In Table 2, parametric estimates and statistical analysis are summarized. Residual analysis by means of Durbin-Watson test demonstrated, in all cases, lack of autocorrelation among them and random distribution (data not shown). The equations were robust and consistent (P-values <0.001 from Fisher's F test) and the adjusted coefficients of multiple determination were always R^2_{adj} >0.993.

No significant differences in the kinetic parameters were observed when the two types of feeding were compared in the two varieties of rooster tested (P>0.05). Nonetheless, the comparison between the two types of roosters led to significant differences in all parameters (P<0.05) less in the lag phase. Thereby, the final growths and rates were higher on Sasso T-44 than Mos breed and the times for semi-maximum growth were lower on Sasso T-44. Although Sasso T-44 birds are slow growing, they belong to a commercial strain genetically selected for meat production, so the animals grew quicker than the Mos breed ones. In chickens, the indigenous breeds are also shown to grow much more slowly than commercial broilers (Wattanachant et al., 2004). Meanwhile, the feed efficiency did not show changes in the coefficients of linear equation for the cases evaluated (average value of b=0.213±0.009 kg of food consumed kg^{-1} of rooster $weeks^{-1}$). Rodriguez (2010) worked with the castrated Mos breed and Sasso T-44 to

obtain “Villalba Capón” (a typical product of Galicia) studied the growth of animals slaughtered at 24 and 32 weeks. This author found LW of 3.867 and 4.641 kg for Mos breed and Sasso T-44 respectively at 24 weeks. Differences of LW might be due to the caponisation effect, although this effect on LW is not so clear. Thus, some studies reported a positive effect (Tor et al., 2002; Mast et al., 1981) whereas others did not find any effect (Zanusso et al., 2001; Duran, 2004) or even that roosters were heavier than capons (Cason et al., 1988; Miguel et al., 2008). Upon comparing Mos growths with those of some Spanish autochthonous breeds it can be observed that Mos breed has superior final LW at the same age, such as Castellana Negra with 2.351 kg (Miguel et al., 2008), Extremeña Azul with 2.145 kg (Muriel et al., 2004), Penedesca Negra with 3.313 kg slaughtered at 28 weeks (Tor et al., 2002).

3.2. Carcass characteristics

Carcass characteristics of Mos and Sasso T-44 roosters are shown in Table 3. Results are expressed in percentage because they showed that the noted differences were not simply due to the birds achieving greater weight but also due to interaction between genetic and nutrition. The effect of breed affected LW and CW ($P<0.001$) and all commercial cuts except for breast and neck ($P>0.05$). No significant influences of finishing feeding treatment ($P>0.05$) were found, except for head ($P<0.01$) and legs ($P<0.05$). Commercial birds at 6 months reached the commercial weight with satisfactory carcass traits. However, as expected, the LW and CW at slaughter clearly differed ($P<0.001$) between genotypes at the same age, due to the lower growth rate of Mos roosters. When comparing with other autochthonous breeds slaughtered at the similar age, CW values of the present study were similar to those reported by Tor et al. (2002) in Penedesenca Negra roosters slaughtered at 28 weeks (2.582 kg), higher than

those reported by Muriel (2004) in 228 day slaughtered Extremeña Azul cocks (1.829 kg) and higher than those indicated by Miguel et al. (2008) in 29 week slaughtered Castellana Negra cocks (1.811 kg). Our results disagree with those published in a previous study for Mos breed (Sanchez et al., 2005) as these authors indicated CW values of 2.111 kg for cocks slaughtered at seven months, lesser than those found it in the present study. Dressing percentage did not differ ($P>0.05$) among genotypes and there were clear differences in main joints between genotypes except for breast cut (Table 3). Drumstick, thigh and wing percentages showed significant differences, since the highest mean values were of Mos roosters and the lowest were of Sasso T-44. However, breast, that is the most highly valued piece of the chicken, was similar for both genotypes. The sum of thigh and drumstick provides an idea of the ratio between the weight of the edible products and the bones, which gives a good image of carcass quality as a whole (Ricard, 1972). In the present study Mos breed had a significantly higher percentage of edible product than Sasso T-44 (34.25 *vs.* 31.19; $P<0.001$). The percentage of head (including the comb) was significantly ($P<0.001$) larger in Sasso T-44 cocks, whereas legs were significantly ($P<0.001$) smaller.

3.3. Meat quality

Chemical composition of drumstick as well as colour and textural parameters from breast for both types of roosters are shown in Table 4. Only significant differences in moisture ($P<0.001$) and myoglobin ($P<0.05$) content between genotype have been found, whereas finishing feeding treatment (corn *vs.* concentrate) affected protein content ($P<0.005$) and all colour traits ($P<0.001$). The mean pH value at 24 h in samples of breast was 5.93. In a previous work with castrated animal of Mos breed and Sasso T-44, Diaz et al. (2010) found pH values of 6.08 and 6.19, respectively. When

comparing our results with those obtained in other autochthonous breeds, we observed that Miguel et al. (2008) obtained a similar value of pH in Castellana Negra whereas De Marchi et al. (2005) found a pH value slightly lesser (5.83) in Padovana breed. Mean values of moisture content in *pectoralis major* muscle (75.14) were inside the range of values described by other authors (74-76%) in improved hybrids commercial breeds for meat production (Wattanachant et al., 2004) and autochthonous breeds (De Marchi et al.,2005; Miguel et al., 2008; Wattanachant et al., 2004). Also, mean values of protein (21.04%) were lesser than the interval of values described in the bibliography for autochthonous breeds (De Marchi et al., 2005; Miguel et al., 2008) and broilers (Ding et al., 1999; Qiao et al., 2002) with protein contents in the range 22.6 to 24.7%. On the contrary, Wattanachant et al. (2004) found protein contents of 20.6% in broilers and these authors pointed out to age differences between birds as a possible explanation. The total collagen amount measured in *pectorali*s muscle was more abundant in the Mos breed and in birds that were fed with corn although it did not reach any statistical significance ($P>0.05$). In this study, animals had been slaughtered at the same age, therefore could not have differed in total collagen content because of age (Dawson et al., 1991) but mainly by the genotype. In the same sense, similar results were found by Jaturasitha et al. (2008) when they worked with four genotypes of chickens.

Regarding colour instrumental traits, roosters fed with corn showed a significantly higher luminosity ($P<0.001$) and redness ($P<0.001$) in *pectoralis* muscle, as well as less yellowness, than cocks fed with commercial fodder. Meat and skin colour are influenced by various factors including heme-pigments, genetics and feeding (Fletcher, 1999; Xiong et al., 1999) and the present study confirmed the presence of a strong feeding influence. According to Fletcher (2002) breed is a factor that affects poultry meat colour; however in our study there were not significant differences. In the same

line, Diaz et al. (2010) found differences in L^* and a^* between Mos roosters and Sasso T-44.

Cooking loss of 8.55-9.55% for Mos and Sasso T-44, respectively, was lower when compared to the 33% and 31% reported for organic and broiler chickens (Castellini, et al., 2002) and 19-23% found for the Thai indigenous chicken (Jaturasitha et al., 2008; Wattanachant et al., 2004). Results in the same range were found in Padovana breed chicken (13-14%) (De Marchi et al., 2005). When compared with a previous study on Mos breed at similar age, Sanchez et al. (2005) reported values of 12.17%, while Diaz et al. (2010) observed higher values (18.1%) than those found in our study. Differences can be explained, taking into account that CL increases with the increment of the temperature or/and time (Lepeti et al., 2000) and important differences in CL methodology exist between studies.

Textural parameters, measured by WB test or TPA test were not significantly affected by genotype or finishing feeding treatment in disagreement with other authors (Jaturasitha et al., 2008) who found differences in breast muscle shear force in four different genotypes. In addition, compared to our findings, these aforementioned authors reported higher shear force values (3.87 kg). Diaz et al. (2010) reported values of 3.51 kg/cm^2 for Mos breed slaughtered at 6 months and these authors did not found breed effect when comparing Sasso T-44 and Mos, which is consistent with our study.

In different species, it has been established that the values of shear force increased with age, due to an increase in the hardness of the connective tissue and also due to an increase in the collagen cross-linking (Fletcher et al., 2002; Aberle et al., 2001). This is noticeable in the present study, as shear force levels were slightly higher than those found for broiler breast meat (Fanatico et al., 2005; Cavit et al., 2004). Despite the fact that meat tenderness is affected by IMF, moisture, and collagen content, we did not find

significant correlations between physicochemical parameters and instrumental textural traits.

3.4. Fatty acid composition

The fatty acid (FA) composition of the finishing diets is shown in Table 1. The greatest difference between treatments was found for the linoleic acid and PUFA content, two times higher in corn diet. The intramuscular FA percentage (g/100 g of total FA) composition is shown in Table 5. For both genotypes, the FA proportions in this study are predominated by MUFA, SFA and PUFA with mean values of 39.25%, 35.43% and 25.27 %. Mos breed contained a higher percentage of SFA and MUFA (36.26 *vs.* 34.61; $P<0.001$; 26.60 *vs.* 23.95; $P<0.001$, respectively) and lower percentage of MUFA (37.07 *vs.* 41.44; $P<0.001$) than Sasso T-44 chicken muscles. Only for C20:1 and C20:3n-6 there were no differences between genotype, whereas differences in FA profile were mostly less pronounced between the two feeding treatments. Oleic acid was the main FA in breast fat and reached the highest level in birds feeding with concentrate (37.65%) followed by palmitic acid and linoleic acid. This pattern was consistent with that reported by Sheu and Chen (2002) and De Marchi et al. (2005). However, these results are not in agreement with those reported by Jaturasitha et al. (2008) in breast raw meat of Thai chicken since palmitic was the most abundant FA, followed by linolenic acid. In contrast, other studies reported linolenic as the predominat FA in Castellana Negra cocks (Miguel et al., 2008). Hence, it has been established that FA composition of chicken fat varies with breed, sex and diet (Edwards and Denman, 1975). Mos breed had greater levels of linoleic and stearic acid than Sasso T-44 cocks, whereas palmitic and oleic acid were higher for Sasso T-44 than Mos breed. Regarding diet, as expected when the dietary PUFA level increased (see corn FA in Table 1) PUFA content in the

breast increased significantly (P<0.001; Table 5). To assess the nutritional index of breast meat fat, the PUFA/SFA ratio (P/S) were determined. In this study, breast from Mos breed showed a P/S ratio of 0.73. This P/S ratio was higher than the range values (0.5-0.7) reported as being typical of the Mediterranean diet (Ulbrich and Southgate, 1991) and also than the recommended ratio of 0.45 by the British Department of Health (1994). The P/S ratio for Mos breed was greater than those reported for broilers (0.19) and Thai indigenous chicken (0.06) (Wattanachant et al., 2004). On the contrary, Jaturasitha et al. (2008) found P/S ratio of 0.80 and 0.85 for broiler and Thai indigenous chicken due to strong relationship between dietary fat source and adipose tissue content (Scaife et al., 1994; Lopez Ferrer et al., 1999).

3.5. Amino acid composition

The hydrolizated amino acid profiles (g/100 g protein) are shown in Table 6. The knowledge of the amino acid composition of foods serves as a basis for establishing their potential nutritive value. Breed had a significant effect on leucine and lysine within essential fraction, while arginine and glutamic acid were affected in non essential fraction. On the other hand, finishing feeding treatment had more impact on amino acid profile affecting almost every amino acid with the exception of methionine and valine in essential fraction and hydroxiproline and tyrosine in non essential fraction. Glutamic acid, arginine and aspartic acid were the major amino acids found in the non-essential fraction representing a mean value of 12.43, 9.80 and 8.83% of the protein, respectively. In both breeds, the lowest mean values were found out in hydroxiproline (0.82%), tyrosine (3.92%) and proline (4.04%). In the essential fraction, the major amino acids were lysine and leucine, and we found the highest values in Mos breed (10.37 and 7.79%, respectively). Should be noted that values of lysine (22.09 g/kg fresh meat) and

leucine (16.54 g/kg fresh meat) are higher than those given by the United States Department of Agriculture (USDA, 2011) for goat and sheep meat (lysine: goat = 15.3; sheep = 14.9; leucine: goat = 17.2; sheep = 13.1). The lowest content among the essential amino acids was measured in methionine and again higher values were found in Mos breed, although it did not reach statistical significance. A similar trend had been observed by Elgasim and Alkanhal (1992) and Paul and Southgate (1978) when studying chicken samples, although these authors found higher values for glutamic acid (16.74%) and aspartic acid (10.01%) and lesser for arginine (6.38%). In other species; such as lamb, goat, camel (Elgasim and Alkanhal, 1992; Gorska et al., 1988), pig (Nielsen, 1973; Belitz et al., 2001) and ostrich (Sales and Hayes, 1996) glutamic and aspartic acids in the non-essential fraction and lysine and leucine in the essential fraction, were also the major amino acids.

3.6. Sensorial analysis

Table 7 shows the results for breast meat tested by sensorial panellists. There were significant differences in raw meat between Mos and Sasso T-44 in colour and transparency of the skin ($P<0.01$) and in fat´s hardness, whereas finishing feeding treatment had a significant influenced on colour skin, fat´s hardness and odour intensity. This outcome was expected, as significant differences between genotypes in instrumental colour were reported in the present study (Table 4). Once breast meat was cooked, only hardness was affected by fed treatment, and corn finishing birds showed higher tenderness (4.12 *vs.* 5.87; $P<0.05$, Table 7). Tenderness is generally the most important attribute driving meat acceptance (Fletcher, 2002); however, meat is not a homogeneous product, as there is tenderness variation from fillet to fillet (Cavitt, 2004). On the other hand, juiciness (the amount of perceived juices in the meat during

chewing), which is very important by consumers because of the major meat characteristics influencing eating quality (Maltin, et al., 1997; Latter-Dubois, 2000), was higher in birds finished with corn although it caused no significant difference and consequently these animals showed less fibrousnesses.

ACKNOWLEDGMENTS

References

Aberle, E., J. Forrest, D. Gerrard, E. Mills, H. Hedrick, M. Judge, et al. 2001. Principles of meat science (4th ed.). Iowa: Kendall-Hunt Publishing Company.

AENOR (Asociación Española de Normalización y Certificación). 1979. UNE 87-004-79. Norma Española. Análisis sensorial. Guía para la instalación de una sala de cata. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 1992. UNE 87-017-92. Norma Española. Análisis sensorial. Metodología para establecer el perfil olfato-gustativo. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 1994. UNE 87-001-94. Norma Española. Análisis sensorial. Vocabulario. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 1995. UNE 87-024-95. Norma Española. Análisis sensorial. Guía para la selección, entrenamiento y control de jueces. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 1996a. UNE 87-013-96. Norma Española. Análisis sensorial. Iniciación y entrenamiento de jueces en la detección y reconocimiento de olores. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 1996b. UNE 87-025-96. Norma Española. Análisis sensorial. Perfil de Textura. AENOR, Madrid, Spain.

AENOR (Asociación Española de Normalización y Certificación). 2000. UNE 87-026-00. Norma Española. Análisis sensorial. Guía general y método para la evaluación del color de los alimentos. AENOR, Madrid, Spain.

AOAC 2000. AOAC official method 990.26. Hydroxyproline in meat and meat products. 39.1.27. In Official methods of analysis of AOAC international (17th ed.). Arlington, VA: Association of Official Analytical Chemists.

Belitz H. D., W. Grosch, and P. Scieberle. 2001. Food Chemistry, 5. Auflage, Springer Verlag, Berlin. 572.

Brady, P. L., and M. E. Hunecke. 1985. Correlations of sensory and instrumental evaluations of roast beef texture. J. Food Sci. 50:300–303.

Carreau, J. P., and J. P. Dubacq. 1978. Adaptation of a macro-scale method to the micro-scale for fatty acid methyl transesterification of biological lipid extracts. J. Chromatogr. A 151:384–390.

Cason, J. A., D. L. Fletcher, and W. H. Burke. 1988. Research note: effects of caponization on broiler growth. Poultr. Sci. 67:979-981.

Castellini, C., C. Mugnai, and A. Dal Bosco. 2002. Effect of organic production system on broiler carcass and meat quality. Meat Sci. 60:219-225.

Cavitt, L. C., G. W. Young, J. F. Meullenet, C. M. Owens, and R. Xiong. 2004. Prediction of poultry meat tenderness using razor blade shear, Allo-Kramer shear, and sarcomere length. J. Food Sci. 69:3274–3283.

Dawson, P. L., B. W. Sheldon, and J. J. Miles. 1991. Effect of aseptic processing on the texture of chicken meat. Poult. Sci. 70:2359–2367.

De Marchi, M., M. Cassandro, E. Lunardi, G. Baldan, and P. B. Siegel. 2005. Carcass characteristics and qualitative meat traits of the Padovana breed of chicken. Int. J. Poult. Sci. 4:233-238.

Díaz, O., L. Rodríguez, A. Torres, and A. Cobos. 2010. Chemical composition and physico-chemical properties of meat from capons as affected by breed and age. Span. J. Agric. Res. 8:91-99.

Ding, H., R.J. Xu, and D. K. O. Chan. 1999. Identification of broiler chicken meat using a visible/near-infrared spectroscopic technique. J. Sci. Food Agric. 79:1382–1388.

DOGA 200. Orde de 26 de Abril de 2001 por la que se hace público el patrón de la raza Galiña de Mos y se crea el registro de la raza. Diario Oficial de Galicia. nº 91 de 11 de mayo.

Edwards, H.M. Jr., and F. Denman. 1975. Carcass composition studies 2. Influences of breed, sex, and diet on gross composition of the carcass and fatty acid composition of adipose tissue. Poult. Sci. 54:1230-1238.

Elgasim, E. A., and M. A. Alkanhal. 1991. Proximate compostion, amino acids and inorganic mineral content of Arabian camel meat: comparative study. Food Chem. 45:1-4.

Fanatico, A. C., L. C. Cavitt, P. B. Pillai, J. L. Emmert, and C. M. Owens. 2005. Evaluation of slower-growing broiler genotypes grown with and without outdoor access: meat quality. Poult. Sci 84:1785-1790.

Fletcher, D. L. 1999. Broiler breast meat color variation, pH, and texture. Poult. Sci. 78:1323–1327.

Fletcher, D. L. 2002. Poultry meat quality. World's Poultry Sci. J. 58: 131-145.

Folch, J., M. Lees, and G. H. Sloane-Stanley. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226:497–509.

Franco, D., L. González, E. Bispo, P. Rodríguez, J. I. Garabal, and T. Moreno. 2010. Study of hydrolyzed protein composition, free amino acid, and taurine content in different muscles of Galician blonde beef. J. Muscle Foods 21:769–784.

Franco, D., E. Rodríguez, L. Purriños, S. Crecente, R. Bermúdez, and J. M. Lorenzo. 2011. Meat quality of "Galician Mountain" foals breed. Effect of sex, slaughter age and livestock production system. Meat Sci. 88:292-298.

Fris Jensen, J. 1997. Quality of poultry meat as affected by nutritional factors. XII Europ. Symp. on the quality of poultry meat, Polonia: 37-48

Gorska, I., T. Szmafiko, and G. Krasnowska. 1988. Preliminary physico-chemical and histological characteristics of beef Gullet meat tissue. Food Chem. 27:131-140.

Latter-Dubois. 2000. Poulets Fermiers: Leurs Qualite´s Nutritionnelle et Organoleptiques et la Perception du Consommateur. M.S. Faculte´ des Sciences de l'Agriculture et de L'Alimentation. Univ. Laval, Quebec, Canada

Lepetit, J., A. Grajales, and R. Favier. 2000. Modelling the effect of sarcomere length on collagen thermal shortening in cooked meat: consequence on meat toughness. Meat Sci. 54:239-250.

López-Ferrer, S., M. D. Baucells, A. C. Barroeta, and M. A. Grashorn. 1999. N-3 enrichment of chickenmeat using fish oil: Alternative substitution with rapeseed and linseed oils. Poult. Sci. 78:356–365.

Lorenzo, J. M., L. Purrinos, S. Temperan, R. Bermudez, S. Tallon, S., and D. Franco. 2011. Physicochemical and nutritional composition of dry-cured duck breast. Poult. Sci. 90:931–940.

Jaturasitha, S., T. Srikanchai, M. Kreuzer, and M. Wicke. 2008. Differences in carcass and meat characteristics between chicken indigenous to Northern Thailand (Black-Boned and Thai Native) and imported extensive breeds (Bresse and Rhode Island Red), Poult. Sci. 87:160-169.

Maltin, C. A., C. C. Warkup, K. R. Matthews, C. M. Grant, A. D. Porter, and M. I. Delday. 1997. Pig muscle fibre characteristics as a source of variation in eating quality. Meat Sci. 47:237-248.

MARM (Ministerio de Medio Ambiente y Medio Rural y Marino). 2011.http://aplicaciones.mapa.es/arca-webapp/flujos.html?_flowId=razaAviar-flow&_flowExecutionKey=e2s3[Revised March 2011].

Mast, M. G., H. C. Jordan, and J. H. Mancneil. 1981. The effect of partial and complete caponization on growth rate, yield and selected physical and sensory attributes of cockerels. Poult. Sci. 60:1827-1833.

Miguel, J. A., B. Asenjo, J. Ciria, and J. L. Clavo. 2008. Effect of caponisation on growth and on carcass meat characteristics in Castellana Negra native Spanish chicken. Animal 2:305-311.

Møller, A. 1980. Analysis of Warner Bratzler shear force pattern with regard to myofibrillar and connective tissue components of tenderness. Meat Sci. 5:247–260.

Muriel, A. 2004. The effect of caponization on production indices and carcass and meat characteristics in free-range Extremeña Azul chicken. Span. J. Agric. Res. 2:211-216.

Nielsen, A. J. 1973. Anatomical and chemical composition of Danish Landrace pigs slaughtered at 90 kilograms live weight in relation to litter, sex and feed composition. J. Animal Sci. 36:476-483.

Paul, A., and D. Southgate. 1978. McCance and Widdowson's The Composition of Foods, 4th (revised and extended) edn of MRC Special Report No. 297. Elsevier/North-Holland Biomedical Press, Amsterdam

Qiao, M., D. L. Fletcher, J. Northcutt, and D. P. Smith. 2002. The relationship between raw broiler breast meat color and composition. Poult. Sci. 81:422–427.

R.D. 2129/2008, de 26 de diciembre, por el que se establece el Programa nacional de conservación, mejora y fomento de las razas ganaderas (BOE nº 23 de 27 de enero de 2009)

Rial., D., J. A. Vázquez, and M. A. Murado. 2011. Effects of three heavy metals on the bacteria growth kinetics: a bivariate model for toxicological assessment. Appl. Microbiol. Biotech. (in press). DOI: 10.1007/s00253-011-3138-1.

Ricard, F. H. 1972. Étude de la composition anatomique du poulet. IV- Possibilités d'estimation des pourcentages de viande, d'os et de peau à partir d'une dissection simplifiée des membres. Ann Zootech 21, 49-57.

Rodriguez, L. 2010. Efectos de la raza, edad de sacrifico y alimentación en los parámetros de calidad de la canal y carne del capón de Villaba. Doctoral Thesis.

Sales, J., and J. P. Hayes. 1996. Proximate, amino acid and mineral composition of ostrich meat. Food Chem. 56:167-170.

Sánchez, L., B. de la Calle, A. Iglesias, and B. Sánchez. 2005. Use of native ancestries for the production of chicken label. Arch. Zootec. 206: 491-496.

Scaife, J. R., Moyo, J. Galbraith, H. Michie, W. and V. Campbell. 1994. Effect of different dietary supplemental fats and oils on the tissue fatty acid composition and growth of female broilers. Brit. Poult. Sci. 35:107–118.

Sheu, K. S., and T. C. Chen. 2002. Yield and quality characteristics of edible broiler skin fat obtained from five rendering methods. J. Food Eng. 55:263-269.

Sundrum, A. 2001. Organic livestock farming. A critical review. Livest. Prod. Sci., 67: 207-215.

Tor, M., J. Estany, D. Villalba, E. Molina, and D. Cubiló. 2002. Comparison of carcass composition by parts and tisúes between cocks and capons. Animal Res. 51:421-431.

Touraille, C., J. Kopp, C. Valin, and F. H. Ricard. 1981. Chicken meat quality. 1. Influence of age and growth rate on physicochemcial and sensory characteristics of the meat. Arch. Gefluegelkd. 45:69–76

Ulbricht, T. L. V., and D. A. T. Southgate. 1991. Coronary heart disease: Seven dietary factors. Lancet 338:985–992.

USDA. 2011. www.nal.usda.gov/fnic/foodcomp/search/ [Revised March 2011].

Vázquez, J.A., M. P. González, and M.A. Murado. 2004. Peptones from autohydrolised fish viscera for nisin and pediocin production. J. Biotechnol. 112:299-311.

Vázquez, J.A., and M.A. Murado. 2008. Mathematical tools for objective comparison of microbial cultures. Application to evaluation of 15 peptones for lactic acid bacteria productions. Biochem. Eng. J. 39:276-287.

Wattanachant, S., S. Benjakul, and D. A. Ledward. 2004. Composition, color, and texture of Thai endigenous and broiler chicken muscles. Poult. Sci. 83:123–128.

Xiong, Y. L., C. T. Ho, and F. Shahidi. 1999. Quality characteristic of muscle food. Pages 309–318 in Quality Attributes of Muscle Foods. Y. L. Xiong, C. T. Ho, and F. Shahidi, ed. Kluwer Acad./Plenum Publ., New York, NY.

Zanusso, J., H. Remignon, A. Auvergne, C. Molette, H. Manse, and R. Babile. 2001. Performance characteristics and quality of chicken meat: comparisons between males, females and capons. Brit. Poult. Sci. 42:S42-S43.

CAPTION TO TABLES AND FIGURES

Table 1. Chemical composition and fatty acid profile of commercial fodder and corn

Table 2. Parametric estimations and confidence intervals (α=0.05) corresponding to the equation [3] applied to predict the growth of roosters sacrificed at 24 weeks.

Table 3. Effect of breed (Mos *vs.* Sasso T-44) and finishing feeding (corn *vs.* fodder) on carcass quality.

Table 4. Effect of breed (Mos *vs.* Sasso T-44) and finishing feeding (corn *vs.* fodder) on meat quality (chemical composition of drumstick as well as colour and textural parameters from breast).

Table 5. Effect of breed (Mos *vs.* Sasso T-44) and finishing feeding (corn *vs.* fodder) on fatty acid profile of breast.

Table 6. Effect of breed (Mos *vs.* Sasso T-44) and finishing feeding (corn *vs.* fodder) on protein amino acid profile

Figure 1: Growth of roosters sacrificed at 24 weeks using two finishing feed treatment and two birds genotypes (up) as well as the corresponding feed efficiency (down). Experimental data of growth (points) were fitted to equation [3] (continuous lines). Values of feed efficiency were fitted to a linear equation. A: Mos breed feeding with fodder; B: Mos breed feeding with fodder and corn in the last 4 weeks; C: Sasso T-44 feeding with fodder; D: SassoT-44 feeding with fodder and corn in the last 4 weeks. Error bars are the standard deviations for n=2.

Table 1.

	Fodder[a]	Corn
Dry Matter		
Crude Protein	17.0	
Crude Fibre	3.0	
Organic Matter	---	
Acid Detergent Fiber	---	
Neutral Detergent Fiber	---	
Ash	6.60	
Fat	4.10	
Ca	1.30	
P	0.59	
methionine	0.33	
lysine	0.85	
Na	0.20	
Moisture		
Oil fatty acid composition		
	Fodder	**Corn**
C16:0	34.99	14.13
C16:1	0.21	0.11
C18:0	4.33	1.88
C18:1n9c	31.06	28.52
C18:2n6c	26.77	52.38
C20:1	0.18	0.30
C18:3n3	1.39	1.49
C22:0	nd	0.23
SFA	40.39	16.88
MUFA	51.45	29.04
PUFA	28.16	54.08

Fodder additives vitamine A (UI/kg) 10000, vitamine D3 (UI/kg) 2500, vitamine E((UI/kg) 9, Fe 860 ppm9, zn 850 ppm), Cu (5 ppm), Mn (60 ppm), Co (0.05 ppm), Se 80.20 ppm), Iodine (0.40 ppm) and Fe (425 ppm)

nd= not determined

SFA = saturated fatty acids (sum of C16:0, C18:0, and C22:0).
MUFA = monounsaturated fatty acids (sum of C16:1, C18:1n9c and C20:1).
PUFA = polyunsaturated fatty acids (total, minus SFA and MUFA).

Table 2.

	Mos/fodder	Mos/corn	Sasso T-44/fodder	Sasso T-44/corn
G_m	3.504±0.193	3.398±0.169	4.214±0.177	4.160±0.197
v_m	0.240±0.027	0.239±0.027	0.326±0.038	0.326±0.043
λ	3.852±0.875	3.753±0.829	3.327±0.807	3.409±0.913
μ_m	0.273±0.040	0.282±0.040	0.309±0.043	0.313±0.050
τ	11.166±0.708	10.849±0.640	9.799±0.549	9.794±0.617
R^2_{adj}	0.994	0.994	0.995	0.993
P-value	<0.001	<0.001	<0.001	<0.001

R^2_{adj}: adjusted coefficient of multiple determination. *P*-value from Fisher's *F* test (α=0.05).

Table 3.

	Breed		Feeding		Significance		SEM
	Mos	**T-44**	**Fodder**	**Corn**	**B**	**F**	
Animals	50	30	40	40			
Live weight (kg)	3.27	4.20	3.68	3.56	***	n.s.	0.04
Carcass weight (kg)	2.70	3.53	3.05	2.97	***	n.s.	0.03
Dressing percentage (%)	82.55	84.05	82.95	83.27	n.s.	n.s.	0.43
Commercial cuts (% respect to carcass)							
Weight drumstick	15.18	13.59	14.48	14.69	***	n.s.	0.11
Skin drumstick	0.84	1.05	0.92	0.92	**	n.s.	0.02
Lean drumstick	10.31	8.87	9.71	9.82	***	n.s.	0.08
Bone drumstick	3.88	3.53	3.75	3.75	**	n.s.	0.06
Thigh	19.07	17.82	18.62	18.58	***	n.s.	0.13
Wing	10.27	9.14	9.83	9.86	***	n.s.	0.07
Breast	15.37	15.46	15.17	15.64	n.s.	n.s.	0.12
Head	3.68	4.31	3.92	3.91	***	n.s.	0.05
Neck	6.21	6.29	5.99	6.49	n.s.	**.	0.07
Legs	5.00	4.45	4.67	4.92	***	*	0.06
D+T	34.25	31.41	33.10	33.27	***	n.s.	0.02
Meat/bone	2.67	2.56	2.63	2.63	n.s.	n.s.	0.05

B×F interaction was not significant for any traits

D+T= Drumstick + Thigh

Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. (not significant)

SEM is the standard error of the mean

Table 4.

	Breed		Feeding		Significance		SEM
	Mos	**T-44**	**Fodder**	**Corn**	**B**	**F**	
Chemical Composition (%)							
pH	5.92	5.95	5.92	5.94	n.s	n.s	0.01
Water	75.75	74.40	75.25	75.22	***	n.s	0.09
Protein	21.02	21.18	20.88	21.23	n.s	*	0.08
Fat	0.64	0.73	0.63	0.71	n.s	n.s	0.03
Collagen	1.17	1.06	1.05	1.16	n.s	n.s	0.05
Ashes	1.27	1.27	1.28	1.26	n.s	n.s	0.008
*Myoglobin	2.59	2.33	2.52	2.47	*	n.s.	0.05
Colour Parameters							
Luminosity (*L**)	51.46	51.41	53.45	49.93	n.s	***	0.32
Redness (*a**)	3.17	3.43	2.30	4.00	n.s	***	0.18
Yellowness (*b**)	6.60	6.82	2.77	9.62	n.s	***	0.22
WHC							
Cooking Loss (%)	9.55	8.55	8.79	9.44	n.s	n.s	0.25
Textural Parameters							
Shear force (kg/cm^2)	1.71	1.61	1.64	1.69	n.s	n.s	0.04
Firmness (kg/cm^2)	0.48	0.50	0.47	0.50	n.s	n.s	0.01
Total Work (kg × s)	5.72	4.86	5.61	5.22	n.s	n.s	0.25
TPA-test							
Hardness (kg)	3.47	3.70	3.90	3.31	n.s	n.s	0.18
Springiness (mm)	0.47	0.46	0.48	0.45	n.s	n.s	0.01
Chewiness (kg × mm)	0.95	0.95	1.07	0.85	n.s	n.s	0.06
Gumminess(kg)	1.84	1.93	2.02	1.77	n.s	n.s	0.09
Cohesiveness	0.52	0.53	0.50	0.54	n.s	n.s	0.01

B×F interaction was not significant for any traits

*Myoglobin expressed as (mg/100 g wet meat)

Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. (not significant)

SEM is the standard error of the mean

Table 5.

	Breed		Feeding		Significance			SEM
	Mos	**T-44**	**Fodder**	**Corn**	**B**	**F**	**B×F**	
C14:0	0.51	0.93	0.75	0.59	***	***	n.s.	0.01
C15:0	1.72	1.02	1.29	1.63	**	n.s.	n.s.	0.11
C16:0	22.66	23.75	22.33	23.81	*	***	**	0.24
C16:1*cis*-9	1.69	3.70	2.04	2.85	***	***	***	0.08
C17:0	0.63	0.32	0.52	0.51	**	n.s.	n.s.	0.04
C18:0	10.74	8.59	10.08	9.78	***	n.s.	n.s.	0.15
C18:1*cis*-9	34.16	36.81	37.65	32.65	**	***	**	0.42
C18:2*n*-6	20.86	19.79	19.00	21.91	*	***	n.s.	0.25
C20:1	0.29	0.31	0.34	0.26	n.s.	***	n.s.	0.008
C18:3*n*-3	0.42	0.71	0.61	0.45	***	***	*	0.01
C20:2	0.19	0.13	0.18	0.16	***	n.s.	n.s.	0.006
C20:3*n*-6	0.19	0.21	0.20	0.20	n.s.	n.s.	n.s.	0.007
C20:4*n*-6	4.43	2.83	3.79	3.87	**	n.s.	n.s.	0.24
C22:6*n*-3	0.55	0.26	0.41	0.47	**	n.s.	n.s.	0.03
C24:1	0.78	0.55	0.71	0.69	***	n.s.	n.s.	0.03
SFA	36.26	34.61	34.96	36.32	***	***	**	0.21
MUFA	37.07	41.44	40.82	36.60	***	***	n.s.	0.44
PUFA	26.60	23.95	24.20	27.08	***	***	n.s.	0.34
TUFA	63.73	65.38	65.03	63.67	***	***	**	0.21
Σ*n*-6	25.49	22.83	23.00	25.99	***	***	n.s.	0.32
Σ*n*-3	0.97	0.97	1.03	0.91	n.s.	*	n.s.	0.03
***n*-6/*n*-3**	27.84	24.37	23.03	30.04	*	***	n.s.	0.69
PUFA/SFA	0.73	0.69	0.69	0.74	*	*	*	0.009

Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. (not significant)

SEM is the standard error of the mean

Table 6.

	Breed		Feeding		Significance			SEM
	Mos	**T-44**	**Fodder**	**Corn**	**B**	**F**	**B×F**	
Essential								
Histidine	4.13	4.26	4.20	3.99	n.s.	**	*	0.03
Isoleucine	4.94	4.73	5.02	4.71	n.s.	***	n.s	0.03
Leucine	7.88	7.65	8.01	7.58	**	***	n.s	0.05
Lysine	10.52	10.22	10.64	10.18	*	*	n.s	0.11
Methionine	2.16	1.98	2.13	2.05	n.s.	n.s.	n.s	0.10
Phenylalanine	4.98	5.13	5.24	4.83	n.s.	*	n.s	0.07
Threonine	4.81	4.92	5.13	4.58	n.s.	***	*	0.04
Valine	4.97	5.01	5.09	4.88	n.s.	n.s.	n.s	0.07
Total E	43.64	42.63	44.28	42.25	*	***	n.s	0.22
Non essential								
Arginine	9.43	10.18	10.35	9.08	***	***	***	0.08
Alanine	5.47	5.64	5.80	5.26	n.s.	***	n.s	0.05
Aspartic acid	8.92	8.74	9.18	8.53	n.s.	***	n.s	0.06
Glutamic acid	12.58	12.29	10.78	14.16	*	***	n.s	0.07
Glycine	4.41	4.44	4.53	4.32	n.s.	**	n.s	0.04
Hidroxiproline	0.83	0.81	0.82	0.83	n.s.	n.s.	n.s	0.01
Proline	4.03	4.05	4.16	3.92	n.s.	**	n.s	0.04
Serine	4.11	4.05	4.17	4.00	n.s.	**	n.s	0.03
Tyrosine	4.02	3.83	3.91	3.99	n.s.	n.s.	n.s	0.07
Total NE	54.63	55.18	54.95	54.71	n.s.	n.s.	n.s	0.30
E/NE*	0.79	0.77	0.77	0.80	***	***	n.s	0.003

*E/NE Essential to non –essential amino acid ratio

Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s. (not significant)

SEM is the standard error of the mean

Table 7.

	Breed		Feeding		Significance			SEM
	Mos	**T-44**	**Fodder**	**Corn**	**B**	**F**	**B×F**	
Fresh meat								
Appearance								
Skin								
Colour skin	3.62	6.37	4.25	5.75	**	*	*	0.29
Transparency	3.87	2.00	3.37	2.5	**	n.s.	*	0.29
Colour meat	6.12	5.87	6.00	6.00	n.s.	n.s.	n.s.	0.39
Uniformity meat	6.75	6.75	6.5	7.0	n.s.	n.s.	n.s.	0.21
Hardness fat	6.12	7.12	6.0	7.25	*	**	***	0.16
Odour								
Intensity	6.25	5.12	4.75	6.62	n.s.	**	*	0.27
Liver	0.25	0.75	0.25	0.75	n.s.	n.s.	n.s.	0.16
Cooked meat								
Taste								
Intensity	6.12	5.25	5.87	5.50	n.s.	n.s.	n.s.	0.22
Rancid	0.75	0.75	0.87	0.62	n.s.	n.s.	n.s.	0.25
Liver	2.12	1.12	2.12	1.12	n.s.	n.s.	n.s.	0.37
Textural								
Hardness	5.37	4.62	5.87	4.12	n.s.	*	n.s.	0.35
Juiciness	4.87	5.37	4.37	5.87	n.s.	n.s.	n.s.	0.45
Pastiness	2.00	3.37	2.75	2.62	n.s.	n.s.	n.s.	0.36
Fibrousnesses	3.37	3.37	3.87	2.87	n.s.	n.s.	n.s.	0.39

Significance: *** (P<0.001), ** (P<0.01), * (P<0.05), n.s (not significant)
SEM is the standard error of the mean

Figure 1.