Effect of production system (free range vs. barns) on growth parameters of Mos rooster breed

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Introduction

The Mos chicken 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. 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).

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. 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 have been reported (Rodriguez, 2010), but no more knowledge is published in the literature.

The assessment of a growth model is of particular importance in animal production, because of its practical implications, such as the feeding and management programs to improve the selection and breeding effect.

The objective of this research was study the effect of indoor and outdoor production systems on Mos rooster and commercial heavy line (Sasso T-44) growth parameters.

Material and Methods

Experimental design and animal management

A total of 120 roosters (n=60 of Sasso T-44 line and n=60 of Mos breed) were used. Birds were housed under free range and extensive indoor (barn reared) conditions according to describe by Commission Regulation (CE nº 543/2008, 2008). Animals 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). Additives of fodder were: vitamine A (UI/kg) 10000, vitamine D3 (UI/kg) 2500, vitamine E((UI/kg) 9, Fe (60 ppm), Zn (50 ppm), Cu (5 ppm), Mn (60 ppm), Co (0.05 ppm), Se (0.20 ppm), Iodine (0.40 ppm) and Fe (425 ppm), methionine (0.33%), lisyne (0.85%) and P (0.59%). Intakes of compound feed and live weight (LW) of birds in both treatment groups were recorded biweekly from 2 to 32 weeks.

The biphasic tendencies observed for the growth of roosters sacrificed at 32 were fitted to the sum of two logistic equations, similarly to what happens with the diauxic productions in microorganisms (Vázquez et al., 2009):

$$P = \frac{P_{m1}}{1+\exp\left[\mu_{m1}\left(\tau_1 - t\right)\right]} + \frac{P_{m2}}{1+\exp\left[\mu_{m2}\left(\tau_2 - t\right)\right]} \qquad [1]$$

or reparameterised,

$$P = \frac{P_{m1}}{1+\exp\left[2+\frac{4v_{m1}}{P_{m1}}\left(\lambda_1 - t\right)\right]} + \frac{P_{m2}}{1+\exp\left[2+\frac{4v_{m2}}{P_{m2}}\left(\lambda_2 - t\right)\right]} \qquad [2]$$

where, P_{m1} is the maximum growth in the first sigmoid of the biphasic pattern (kg), P_{m2} is the maximum growth in the second sigmoid of the biphasic profile (kg), μ_{m1} is the specific maximum rate of growth in the first sigmoid of the biphasic pattern (weeks^{-1}), μ_{m2} is the specific maximum rate of growth in the second sigmoid of the biphasic profile (weeks^{-1}), τ_1 is the time required to achieve the half of the maximum growth in the first sigmoid of the biphasic pattern (weeks), τ_2 is the time required to achieve the half of the maximum growth in the second sigmoid of the biphasic profile (weeks), v_{m1} is the maximum rate of growth in the first sigmoid of the biphasic pattern (kg weeks^{-1}), v_{m2} is the maximum rate of growth in the second sigmoid of the biphasic profile (kg weeks^{-1}), λ_1 is the lag phase for the first sigmoid (weeks) and λ_2 is the lag phase for the second sigmoid (weeks). Additionally, $P_{mf} = P_{m1} + P_{m2}$ is the final maximum growth (kg) in the biphasic process (value of P when $t \rightarrow \infty$).

In all cases, 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}) and a (kg of food consumed kg^{-1} of rooster) the corresponding slope and y-intercept, respectively. The units of a were kg of food consumed

Numerical methods

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).

Results

Table 1 shows the chemical composition and fatty acid profile of commercial fodder, where, saturated fatty acids (SFA) are sum of C16:0, C18:0, and C22:0; monounsaturated fatty acids (MUFA) are sum of C16:1, C18:1n9c and C20:1; and polyunsaturated fatty acids (PUFA) is the total, minus SFA and MUFA. The results of the roosters grown on barns and corresponding FE are depicted in Figure 1. The profiles adjusted to the experimental data according to the model [2] are also displayed. Figure 2 show the experimental and fitting results of roosters living on free range and sacrificed at 32 weeks. In Table 2, parametric estimates and statistical analysis for both growth conditions 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).

Discussion

Roosters living on extensive indoor slaughtered at 32 weeks

In general, the biphasic equations proposed were statistically robust (*p*-values for Fisher's *F* test <0.001), the parametric estimations were almost always significant (Student's *t* test, α = 0.05) and R^2_{adj} was always superior to 0.995. The differences between genotypes were statistically significant ($P<0.05$), in where Sasso was the variety that generated the best growths and associated parameters. The values of *b* were not dependent on the breed investigated proposing an average value of 0.202±0.009 kg of food consumed kg^{-1} of rooster $weeks^{-1}$.

Roosters living on free range slaughtered at 32 weeks

The results of the roosters grown on free range and sacrificed at 32 weeks are shown in Figure 2. The predictability of equation [2] in these cases was lower than in the rest of the trials due to the high number of non significant parameters obtained in the fit of the experimental data. These poor results are motivated by the lack of a clear final asymptote. Nonetheless, Sasso growth was higher than Mos and differences between conditions of living (barns *vs.* free range) were not observed ($P>0.05$). The values of *b* were again independent on the breed studied proposing an average value of 0.190±0.008 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.

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).

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Abstract

Nowadays, Mos rooster is the only autochthonous breed of the Galicia (NW Spain) that is included in the Official Catalogue of Cattle's Breeds of Spain as being in danger of extinction. This breed is known for its great rusticity which allows them to adapt to extensive production system. The objective of this research was study the effect of indoor and outdoor production systems on Mos rooster and commercial heavy line (Sasso T-44) growth parameters. A total of 120 roosters were used. All birds were weighed at birth and biweekly from 2 to 32 weeks.

The biphasic tendencies observed for the growth of roosters sacrificed at 32 weeks were fitted to the sum of two logistic equations similarly to what happens with the diauxic productions in microorganisms. 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. Hybrid line generated the best growths and associated parameters and significant differences between conditions of living (barns *vs.* free range) were not observed (P>0.05).

Keywords: Indigenous breed, Sasso T-44, animal behavior, environment, growth curve

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

Crude Protein	17.0
Crude Fibre	3.0
Ash	6.60
Fat	4.10
Oil fatty acid composition	
C16:0	34.99
C16:1	0.21
C18:0	4.33
C18:1n9c	31.06
C18:2n6c	26.77
C20:1	0.18
C18:3n3	1.39
SFA	40.39
MUFA	51.45
PUFA	28.16

Table 2. Parametric estimations and confidence intervals (α=0.05) corresponding to the equations [1] and [2] applied to predict the growth of roosters sacrificed at 32 weeks after living on barns or free range. NS: non significant; R^2_{adj}: adjusted coefficient of multiple determination. *p*-value from Fisher's *F* test (α=0.05).

	BARNS		FREE RANGE	
	*Mos*_fodder	*Sasso*_fodder	*Mos*_fodder	*Sasso*_fodder
P_{m1}	3.483±0.445	4.142±0.260	2.953±1.916	3.886±0.612
v_{m1}	0.228±0.026	0.344±0.034	0.225±0.081	0.347±0.029
λ_1	3.713±0.914	3.509±0.629	3.455±0.685	3.539±0.462
μ_{m1}	0.262±0.051	0.332±0.045	0.304±0.101	0.357±0.052
τ_1	11.351±1.295	9.534±0.588	10.025±2.093	9.136±0.605
P_{m2}	0.856 (NS)	1.219 (NS)	1.672 (NS)	3.547 (NS)
v_{m2}	0.095±0.072	0.127±0.062	0.085±0.024	0.174 (NS)
λ_2	25.121±6.385	24.699±3.632	16.849 (NS)	25.648 (NS)
μ_{m2}	0.442 (NS)	0.416 (NS)	0.203 (NS)	0.197 (NS)
τ_2	29.645±9.252	29.505±6.296	26.702±6.160	35.795 (NS)
P_{mf}	4.339±1.693	5.361±1.489	4.626±2.058	7.430 (NS)
R^2_{adj}	0.995	0.997	0.998	0.998
p-value	<0.001	<0.001	<0.001	<0.001

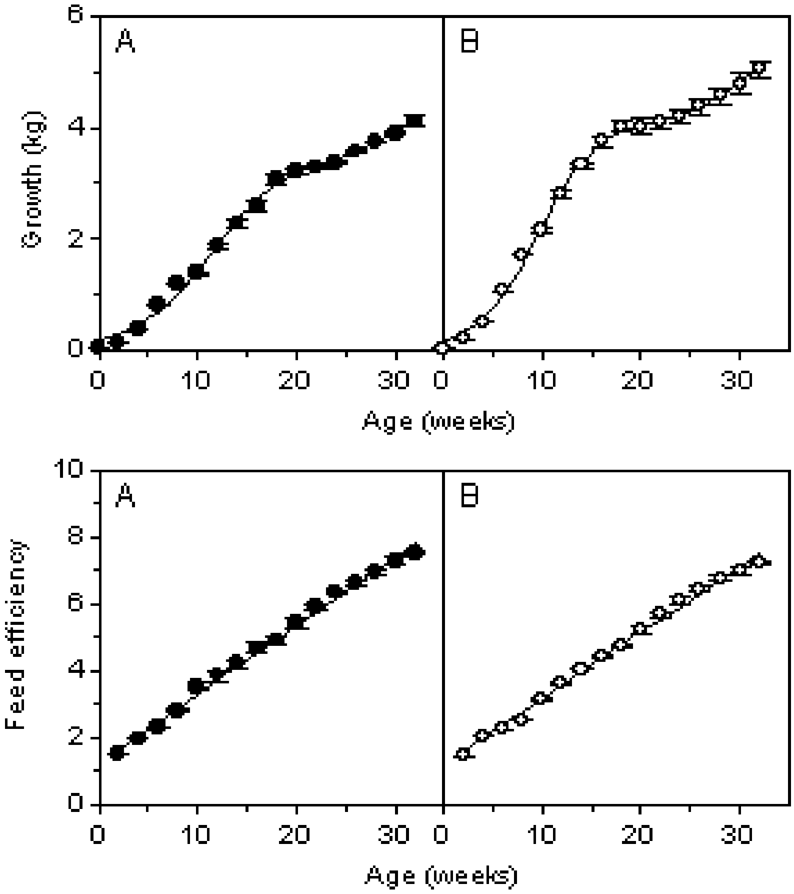

Figure 1. Growth of roosters living on barns and slaughtered at 32 weeks of two genotypes of animal (up) as well as the corresponding feed efficiency (down). Experimental data of growth (points) were fitted to equation [2] (continuous lines). Values of feed efficiency were fitted to a linear equation. A: Mos breed; B: Sasso T-44. Error bars are the standard deviations for n=2

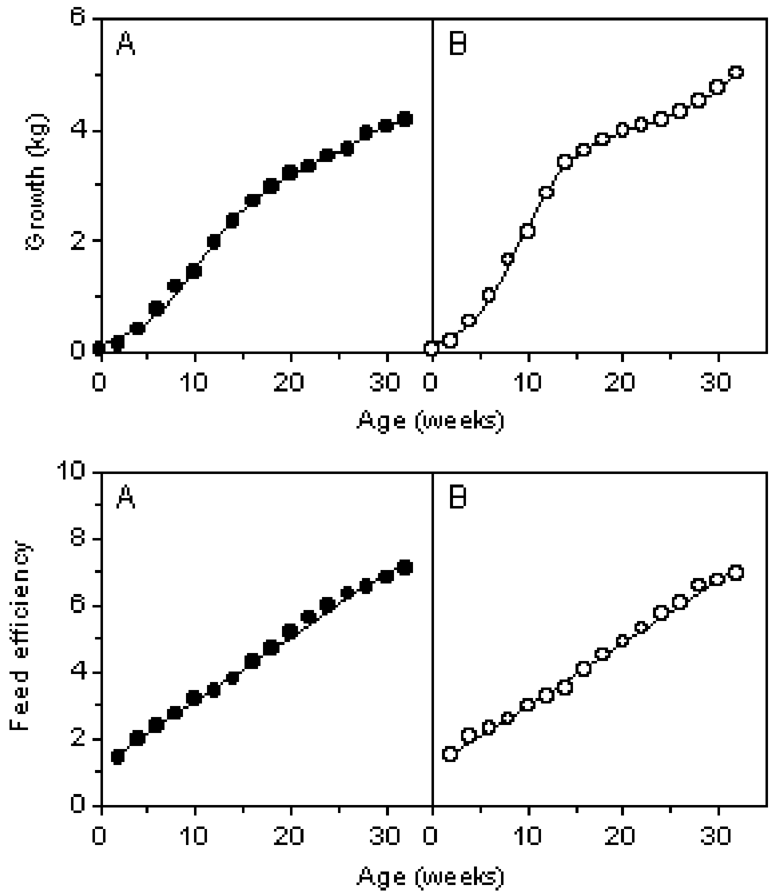

Figure 2. Growth of roosters living on free range and slaughtered at 32 weeks of two varieties of animal (up) as well as the corresponding feed efficiency (down). Experimental data of growth (points) were fitted to equation [2] (continuous lines). Values of feed efficiency were fitted to a linear equation. A: Mos breed; B: Sasso T-44