Growth Rate, Slaughter Traits and Meat Quality of Lambs of Three Alpine Sheep Breeds

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Summary

A fattening and slaughter trial was carried out on 36 lambs of Alpagota, Brogna and Foza sheep breeds native of Veneto Region Alps (six male and six female lambs per breed) divided in three groups depending on the type of feed used: pasture, hay and concentrate, hay and concentrate supplemented with conjugated linoleic acid. Lambs were slaughtered at 225 days (mean weight: 30 kg). *Infra-vitam* and *post-mortem* data were analyzed by using a linear model that included the cross-classified effect of breed, sex, feeding system and age of lambs as linear covariate. The three breeds showed some specificity: Foza lambs, of both sexes, were larger-sized and faster growing, with a lower incidence of gastro-intestinal tract and lower cooking losses of the hind-leg samples compared to the other two middle-sized breeds. Alpagota breed tended to be leaner, with heavier shin and greater cooking losses than Brogna breed. In conclusion the three Alpine breeds of the Veneto Region confirmed to be able to produce lamb carcasses and meat with valuable characteristics that can be exploited through typical products and food preparation in local markets and gastronomy, according to the tradition. The valorisation of these productions can be an important instrument for *in situ* conservation of these breeds.

Key words

lamb, meat quality, carcass traits, breed

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Received: June 1, 2011 | Accepted: July 10, 2011

Aim

Alpagota, Brogna and Foza, together with Lamon, are the sheep breeds originated in the mountain (Italian eastern Alps) of Veneto Region. Alpagota, Brogna and Foza have shown a genetic specificity that identifies them as genetic resources to be protected (Bittante, 2011; De Marchi et al., 2005; Dalvit et al., 2008, Dalvit et al., 2009). All these breeds are endangered because of the low number of existing animals. They are reared in small farms at pasture, according to tradition, even if some researches to increase their productivity have been carried out (Bittante and Pastore, 1988; Bittante et al., 1996; Bonsembiante et al., 1988). These sheep populations are still used for some traditional conserved meat preparation (Paleari et al., 2006; Bovolenta et al., 2008). The aim of this study was to estimate the effect of breed and sex on growth rate, slaughter traits and meat quality traits of lambs of Alpagota, Brogna and Foza breeds.

Material and methods

This experiment was conducted from July 2010 to, November 2010 at the "Lucio Toniolo" Experimental Farm of the University of Padova in Legnaro (Padova, Italy). The lambs used for this research belong to two flocks undergoing an *in situ* conservation program (Legnaro – Villiago). In total 36 animals were used: six males and six female for each breed, Alpagota, Brogna and Foza. Lambs were divided in three groups (two males and two females for each breed) with different feeding systems: a) pasture, b) penned in an open barn and fed with hay and concentrate, and c) penned in the open barn and fed with hay, concentrate and supplemented with 8.0 g/d of a rumen protected conjugated linoleic acid (rpCLA) product (Sila, Noale, Italy).

Each month lambs were weighed and measured, recording live weight, height at withers, thoracic circumference and body condition score (BCS).

At the age of 225 days and mean weight of 30 Kg lambs were slaughtered.

At the slaughterhouse the following weighs were recorded: live weight, skin, feet, head, gastro-intestinal tract, offal (trachea, lungs, heart and spleen), liver, and genitals. Carcasses were divided in two halves, weighed and cold stored at 4°C. The day after slaughter, halves were weighed again and the right half-carcasses were measured and dissected into five cuts (hind-leg, fore-leg and shoulder, ribs-loin, withers, brisket). On the hind leg and the rib-loin muscle pH and temperature were measured. The pH and temperature were measured using a Crison PH 25 pH-meter equipped with a penetrating electrode. Each cut was weighed and stored under vacuum at 4°C. After six days the packages were open, the cuts were dried and weighed and the drip loss were computed.

In the Meat Quality Laboratory of the Department of Animal Science of Padova University, two cuts (hind-leg and rib-loin) were weighed and dissected. Rib-loin was divided in ribs and loin sections. Ribs were dissected, and weighed, in meat and bones. Loins were dissected, and weighed, in bones, subcutaneous fat and muscle (*Longissimus lumborum*). From hind-legs, only the inner part of the round (*Quadriceps femoris*) was separated and weighed. From each muscle sample pH, temperature and drip loss were obtained.

All traits were analyzed with the following linear model, using the PROC GLM of SAS (2008):

$$y_{ijklm} = \mu + age_i + feeding_j + breed_k + sex_l + e_{ijklm}$$

where y = experimental observation, μ = overall mean, age_i: linear covariate of age, $feeding_j$: effect of feeding treatment (j = pasture; hay and concentrates; hay, concentrates and rpCLA), $breed_k$: effect of breed (k = Alpagota, Brogna and Foza); sex_l: effect of sex (l = F and M); e_{ijklm}: random residual term ~ N (0, σ^2_e).

Results and discussion

Initial and final live-weight and growth rate of Alpagota, Foza and Brogna lambs are reported in Table 1.

The initial and final live-weight of the lambs reflects the different size of the three Veneto sheep breeds. The Alpagota and Brogna breeds lies at the two extremes for genetic and geographic distances, but not in terms of size ($P = 0.083$ and n.s., respectively at the beginning and at the end of the trial). The Foza lambs, genetically and geographically intermediate between Alpagota and Brogna, were heavier than the lambs of the other breeds at both dates ($P < 0.001$). The differences in growth rate of the lambs of the three breeds were not significant, even if the contrast between the Foza breed and the other two breeds approached the statistical significance ($P = 0.066$). It was observed that when growth rate was expressed in relation to the initial size of animal - allometric coefficient – the growth rate of the three breeds was very similar.

The differences among breeds of body condition score (BCS), i.e. of fatness of animals, were much more pronounced at the beginning than at the end of the trial (Table 1), reflecting, probably, different maternal milk production. The Brogna lambs were fatter than Alpagota lambs at both dates, while Foza lambs were fatter than the other two breeds at the beginning but not at the end of the trial.

Sex of lambs influenced only the final live-weight with the males heavier than females (+11.1%, $P < 0.05$). It should be considered that the majority of animals were in their pre-pubertal period.

The effect of age (linear regression) was significant on initial and final live-weight ($P < 0.001$), on allometric coefficient ($P = 0.012$) and on final BCS ($P = 0.011$), but not on daily growth rate and initial BCS.

The effect of breed, sex and age of lambs on slaughter data are summarized in Table 2.

In respect to Alpagota, Brogna lambs were characterized by a smaller incidence of the pelt and by a tendency for a higher dressing percentage, while Foza lambs were heavier at slaughter and yielded heavier carcasses with comparable dressing percentages in respect to the lambs of the other two breeds. Moreover, they were characterized by a higher incidence of feet and by lower incidences of gastrointestinal tract and offal.

The males were heavier at slaughter ($P < 0.05$) but yielded carcasses not significantly different because of their lower killing out percentage. The tendency for a lower skin and liver was counterbalanced, in males, by higher incidence of genitals and of gastro-intestinal tract.

Table 1. Least square means (LSM) of breed and sex and significance of breed contrasts and of initial age covariate on average growth rate, allometric coefficient and BCS of Alpagota (A), Foza (F) and Brogna (B) lambs

	Breed LSM			Breeds contrasts (*P*)		Sex LSM		Age (*P*)	RMSE
	A	F	B	A *vs* B	F *vs* (A+B)	M	F		
Live weight (kg)									
Initial	17.3	25.0	20.6	0.083	< 0.001	21.7	20.3	< 0.001	3.60
Final	25.8	35.9	28.9	n.s.	< 0.001	31.8 [b]	28.6 [a]	<0.001	4.17
Growth rate (g/d)	75.7	96.8	74.6	n.s.	0.066	90.9	73.7	n.s.	25.7
Allometric coef.	1.14	1.11	1.12	n.s.	n.s.	1.13	1.12	0.012	0.04
BCS (1-5)									
Initial	2.65	3.31	3.14	0.002	0.002	3.00	3.07	n.s.	0.28
Final	3.02	3.25	3.28	0.019	n.s.	3.23	3.14	0.011	0.22

a, b P<0.05

Table 2. Least square means (LSM) of breed and sex and significance of breed contrasts and of initial age covariate on slaughter traits of Alpagota (A), Foza (F) and Brogna (B) lambs

	Breed LSM			Breed contrasts (P)		Sex LSM		Age (P)	RMSE
	A	F	B	A *vs* B	F *vs* (A+B)	M	F		
Slaughter-wt, kg	26.17	36.24	28.95	n.s.	<0.001	32.18[b]	28.73[a]	<0.001	4.41
Skin, %	13.84	12.80	11.48	0.009	n.s.	12.2[α]	13.2[β]	n.s.	1.67
Head, %	6.07	5.98	6.00	n.s.	n.s.	5.91	6.11	n.s.	0.36
Feet, %	2.24	2.62	2.20	n.s.	<0.001	2.37	2.34	0.023	0.17
Gastroint. tract, %	30.72	27.53	30.15	n.s.	0.006	30.48[b]	28.45[a]	<0.001	2.19
Offal[1], %	2.55	2.26	2.52	n.s.	0.024	2.37	2.51	n.s.	0.27
Liver, %	1.41	1.34	1.34	n.s.	n.s.	1.34[α]	1.38 [β]	0.097	0.06
Genitals, %	0.39	0.37	0.47	n.s.	n.s.	0.69[B]	0.13 [A]	n.s.	0.23
Dressing, %	41.08	43.65	42.64	0.083	n.s.	41.64[A]	43.28[B]	<0.001	1.63
Carcass wt:									
Hot, kg	10.75	15.87	12.46	n.s.	<0.001	13.51	12.54	<0.001	2.05
Cold, kg	10.09	14.60	11.74	0.090	<0.001	12.84	11.90	<0.001	1.98

α, β P<0.10; a, b P<0.05; A, B :P<0.01; [1]: trachea, lungs, heart and spleen.

Table 3. Least square means (LSM) of breed and sex and significance of breed contrasts and of initial age covariate on meat pH, drip and cooking losses of meat from Alpagota (A), Foza (F) and Brogna (B) lambs

	Breed LSM			Breed contrasts (P)		Sex LSM		Age (*P*)	RMSE
	A	F	B	A *vs* B	F *vs* (A+B)	M	F		
pH:									
Loin	5.61	5.63	5.64	n.s.	n.s.	5.67[b]	5.58[a]	n.s.	0.12
Hind-leg	5.50	5.56	5.54	0.097	0.089	5.53	5.53	n.s.	0.05
Drip loss (%)									
Loin	1.43	1.26	0.91	n.s.	n.s.	0.98	1.41	n.s.	1.28
Hind-leg	0.47	0.53	0.63	n.s.	n.s.	0.32[a]	0.76[b]	n.s.	0.49
Cooking loss (%)									
Longissimus thoracis	26.7	24.1	23.1	0.006	n.s.	24.1	25.1	n.s.	2.39
Quadriceps femoris	40.7	37.8	39.0	0.034	0.005	39.9[B]	38.4[A]	0.012	1.53

a, b P<0.05; A, B :P<0.01

Age influenced significantly the weight of lambs at slaughter and of their carcasses, but also of their dressing percentage and incidence of feet and gastro-intestinal tract.

Table 3 shows the effects of breed, sex and age of lambs on some physical quality traits of two meat sample joints.

While pH and drip loss were not significantly affected by breed, cooking losses were greater for meat samples from Alpagota than from Brogna lambs and smaller for Foza meat samples from hind-leg but not from loin.

Female lambs were characterized by lower pH, greater drip losses and smaller cooking losses, but only on meat samples from hind-legs, also because of the greater residual variability found on loin samples.

The only effect exerted by age of lambs was on the cooking losses of *Quadriceps femoris*.

Several authors observed that the effect of breed is often associated with differences in muscle distribution and consequently in the proportions of the various joints in the carcass (Santos-

Silva et al., 2002). Breed effects on meat quality seems to be not important when referred to pH, amount of pigments, physical color, instrumental hardness and sensorial characteristics (Santos-Silva et al., 2002) but it is important for the evolution of sensory traits that were not reported in this paper (Solomon et al., 1980; Arsenos et al., 2002; Martìnez-Cerezo et al., 2005). The results of Lind et al. (2011) support the hypothesis that the difference for meat quality between different breeds could be small when lambs are slaughtered at equal degrees of maturity. The most important differences often found in literature are referred to color and texture and can be justified by differences in precociousness or in the muscularity degree (Sanudo et al., 1998).

Conclusions

In conclusion the three Alpine breeds of the Veneto Region confirmed to be able to produce lamb carcasses and meat with valuable characteristics that can be exploited through typical products and food preparation in local markets and gastronomy, according to tradition. The valorisation of these productions can be an important tool for the *in situ* conservation of these breeds. As an example of that, Slow Food organization has recognized "Agnello Alpagoto" (lambs of Alpagota breeds) as a Slow Food Presidium. Moreover the three breeds confirmed also some differences among them. In particular Foza breed is characterized by a large size and growth rate, a lower incidence of gastro-intestinal tract and by lower cooking losses of the hind-leg samples compared to the other two middle-sized breeds. Alpagota breed tended to be leaner, with heavier shin and higher cooking losses than Brogna breed. These differences evidenced some peculiarity of the three breeds that can be of value for their possible use in different segments of the food-service chain.

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acs76_57