EFFECT OF SHEEP BREED ON HAY INTAKE, IN VIVO DIGESTIBILITY AND HAY RUMINAL KINETICS AS AFFECTED BY SOYBEAN SUPPLEMENTATION

A.L.G. Lourenço, P. Fontes and A.A. Dias-da-Silva*

CECAV-UTAD, Department of Animal Science, P.O. Box 1013, 5001-801 Vila Real, Portugal

*Corresponding author: *analou@utad.pt*

1 – Message

- Churra da Terra Quente – a small native Portuguese sheep breed – exhibited higher dry matter intake of hay *per* kg live weight, lower digestibility and higher rumen outflow rate than Ile de France breed (Lourenço *et al*., 2000: Lourenço *et al*., unpublished data).
- There are no differences between these breeds in rumen fermentation.
- Apparently differences in intake and digestibility among these breeds are only the result of rumen outflow rate differences.

2 - Introduction

Churra da Terra Quente (CTQ; mature weight: 45-50 kg) is the most important sheep breed reared in the Northeast region of Portugal. It is well known by its rusticity. In previous work, comparing this breed with Ile-de-France (IF), the authors reported for lambs (Lourenço *et al*., 2000) and for ewes (Lourenço *et al*., unpublished data), higher dry matter intake (DMI; g/kg live weight), lower OM digestibility (OMD) and higher rumen outflow rates in CTQ than in Ile de France (IF) breed fed *ad libitum* and, with ewes, also at the same level of intake *per* kg live weight (Lourenço *et al*., unpublished data).

Reports comparing rumen environment and kinetics of sheep breeds have been published (*e.g.* Ranilla *et al*., 1997, 2000; Molina *et al*., 2001). In these reports differences among breeds have been found.

The present study was designed to further clarify digestive differences between CTQ and IF breeds.

3 - Materials and methods

3.1 - Animals, design and management

Four CTQ and four IF non-pregnant and non lactating cannulated ewes (5- to 6-yr-old, average live weight (LW) 39.2 ± 3.7 and 71.4 ± 1.9, respectively) were used. All animals were kept indoors with 14 h light *per* day in individual pens with slatted floors and had free access to water. The ewes of each breed were divided in 2 groups of 2 animals each. One group of each breed was fed with hay and the other with hay plus soybean meal (SBM; 150g/kg hay DM intake). All animals were fed *ad libitum* accepting a refuse level of 20.7 ± 1.25%. Hay was offered in two approximately equal meals *per* day (08:00 and 16:00 h). Soybean meal was offered in the morning before the hay. Nutrient composition of feeds is shown in ***Table 1***.

Table 1 - Chemical composition (g kg^{-1} DM) of feeds used in the experimental diets (mean ± se; n=6)

Feeds	OM	CP	NDF	ADF	ADL
Hay	936.6 ± 1.40	62.0 ± 2.17	661.4 ± 8.09	409.7 ± 5.41	55.1 ± 1.62
Soybean meal	928.5 ± 0.76	452.7 ± 2.79	157.9 ± 4.71	102.5 ± 3.02	9.64 ± 3.82

DM, dry matter; OM, organic matter; CP, crude protein; NDF, neutral detergent fibre; ADF, acid detergent fibre, ADL, acid detergent lignin. nd, not determined.

After a period of two weeks of adaptation and four weeks of measurements (***Period 1***; ***Figure 1***), diets within breeds were switch between animal groups and after a month interval all procedures were repeated (***Period 2***).

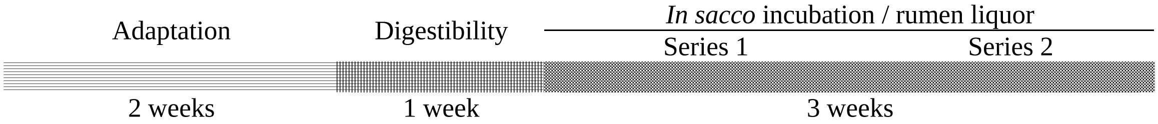

Figure 1. – Time line of each trial period.

During measurement of *in vivo* digestibility representative samples of feeds, refusals and faeces were collected daily for DM determination. The dried samples were bulked *per* week for chemical analysis.

The rumen degradation was measured using the nylon bag technique (Ørskov *et al*., 1980). The hay incubation times were 0, 2, 4, 8, 16, 24, 48, 72, 96, 120 and 144h. Two incubation series were made in two consecutive weeks in each period. After the last time of each incubation series rumen liquor samples (50ml) were collected through the cannula of each sheep at 2, 4, 6, 9, 12, 15, 19 and 24 h after the morning meal.

3.2 - Models

The DM and NDF degradability were calculated from fitting the values to the model $P = a + b [1 - exp(-ct)]$ proposed by (Orskov and McDonald, 1979), modified by (McDonald, 1981), using the NLin procedure of SAS (1999-2001). In this model, P is the cumulative DM or NDF at time t, a is the readily soluble fraction, b is the insoluble but potentially degradable fraction, c is the rate constant for the degradation of fraction b, t is time (h). Effective rumen disappearance of DM (ERD_{DM}), NDF (ERD_{NDF}) was calculated as $ERD = a + bc/(c + ks)$ (Orskov and McDonald, 1979) were ks is the solid rumen outflow rate.

3.3 - Chemical and statistical analysis

Samples of feeds, faeces and refusals were prepared for chemical analyses according to current procedures. Ash, Kjeldahl-N, neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to standard procedures. *In vitro* digestibility after 24 h fermentation of feces NDF was measured according to the Tilley and Terry (1963) method, as modified by Marten and Barnes (1980).

Analysis of variance of *in vivo* digestibility, *in sacco* incubation data, and the rumen fermentation characteristics were conducted using MIXED procedure of SAS (1999-2001). Animal within breed was included as random variable in every model. In the analysis of intake, *in vivo* digestibility and *in sacco* and *in vitro* incubation data breed, diet, period were considered fixed effects. In the analysis of variance of rumen fermentation characteristics breed, diet, period, hour were considered fixed effects and hour within animal within period was considered a repeated measurement.

3 - RESULTS AND DISCUSSION

One IF ewe was removed from the digestibility trial due to cannulae instability.

The inclusion of two periods in this trial aimed to increase the number of observations once increasing the number of cannulated ewes was not an available option. Although the period effect of the trial was significant (P>0.05) for many of the items studied (***Table 2***; ***Table 3***), this was probably due to the small number of animals and eventually to the reduced duration of intake measurements – nevertheless reliable, taking into account previous trials – or to the small but expected variation in feeds and environmental conditions. The interaction of period with the other main effects was not significant (P>0.05). Including the period in the statistical model we expected to remove these period effects from the breed and diet effects.

Table 2 - Effects of breed (B), nitrogen supplementation (D) and period (P) on total diet and hay dry matter intake (DMI) and digestible organic matter intake (DOMI) and diet and hay *in vivo* digestibility and faeces *in vitro* digestibility.

Item[1]	Breed[2]		SEM[5]	Diet[3]		Period[4]		SEM[5]	P-value		
	CTQ	IF		H	HS	P1	P2		B	D	P
Diet DMI											
g/kg LW	26.2	20.2	1.43	21.1	25.3	19.8	26.6	1.31	0.03	0.05	0.01
g/kg$^{0.75}$ LW	65.4	58.4	3.65	56.4	67.4	52.8	71.0	3.26	0.23	0.04	0.01
Hay DMI											
g/kg LW	24.3	18.9	1.31	21.2	22.0	18.4	24.7	1.17	0.03	0.55	0.01
g/kg$^{0.75}$ LW	60.6	54.6	3.24	56.5	58.7	49.3	65.9	2.88	0.25	0.57	0.01
Diet digestibility, %											
OM	55.5	59.0	0.81	54.9	59.5	58.4	56.0	0.66	0.03	0.001	0.01
NDF	48.7	54.4	1.36	50.9	52.2	50.9	52.2	1.21	0.03	0.39	0.42
Hay digestibility, %											
OM	53.1	56.9	0.86	54.9	55.1	56.4	53.7	0.74	0.03	0.83	0.02
Diet DOMI											
g/kg LW	12.7	10.3	0.74	10.8	12.2	10.1	12.9	0.66	0.08	0.15	0.02
g/kg$^{0.75}$ LW	34.1	32.1	2.09	28.9	37.3	29.0	37.2	1.87	0.53	0.02	0.02
Faeces digestibility, %											
NDF	17.8	11.6	1.20	14.9	14.5	14.7	14.8	1.11	0.01	0.81	0.95

[1]DM, dry matter; OM, organic matter; NDF, neutral detergent fibre; [2]CTQ, Churra da Terra Quente; IF, Ile de France. [3]H, hay; HS, hay + soybean meal (150 g kg^{-1} hay DM intake). [4]P, Period. [5]SEM, standard error of the mean.

Table 3. Effects of breed (B), protein supplementation (D) and period (P) on rumen liquor pH and N-NH3 (mg/L) and on in situ disappearance kinetics of hay DM and NDF.

Item	Breed[1]		SEM	Diet[2]		Period[3]		SEM	P-value			
	CTQ	IF		H	HS	P1	P2		H	B	D	P
pH	6.63	6.56	0.046	6.62	6.56	6.61	6.57	0.034	0.001	0.36	0.01	0.03
NH3-N	97.8	101.6	16.93	62.8	136.6	71.9	127.5	12.25	0.01	0.88	0.001	0.001
Hay DM[4]												
Fraction A	20.0	19.7	0.22	19.9	19.9	20.9	18.9	0.26	-	0.41	1.00	0.001
Fraction B	50.7	49.6	0.47	50.2	50.3	49.6	50.9	0.41	-	0.24	0.83	0.03
Fraction U	29.3	30.5	0.44	29.9	29.8	29.6	30.2	0.39	-	0.12	0.83	0.21
k_d	0.040	0.040	0.0024	0.039	0.041	0.039	0.041	0.0020	-	1.00	0.22	0.36
ERD_{eq}	53.6	52.7	0.70	52.7	53.7	53.4	53.0	0.60	-	0.43	0.20	0.50
ERD_{obs}	47.6	52.8	0.72	49.7	50.7	50.4	49.9	0.61	-	0.01	0.18	0.51
Hay NDF[4]												
Fraction A	5.9	6.2	0.26	6.2	5.9	6.6	5.5	0.25	-	0.43	0.50	0.02
Fraction B	62.9	61.7	0.84	62.6	61.9	61.3	63.3	0.71	-	0.36	0.42	0.04
Fraction C	31.2	32.1	0.81	31.2	32.1	32.1	31.2	0.67	-	0.47	0.23	0.24
k_d	0.032	0.031	0.0018	0.030	0.033	0.030	0.033	0.0015	-	0.60	0.06	0.15
ERD_{eq}	44.4	43.4	0.75	43.3	44.5	43.2	44.6	0.66	-	0.37	0.18	0.12
ERD_{obs}	36.7	43.4	0.75	39.3	40.7	39.3	40.7	0.66	-	0.001	0.13	0.12

[1]CTQ = Churra-da-Terra-Quente; IF = Ile-de-France.
[2]H = hay; HS = hay + soybean meal (150 g/kg ingested hay, DM basis).
[3]P1 = first period; P2 = second period.
[4]Fraction A = immediately soluble fraction, Fraction B = disappearing at a measurable rate, and Fraction U = undegraded, k_d = ruminal disappearance rate, ERD = effective ruminal disappearance, calculated as A + B $k_d/(k_d$ + passage rate): ERD_{eq} when mean passage rate (0.02/h; AFRC, 1993) for both breeds, ERD_{obs} mean passage rate was 0.02/h for IF and 0.033/h for CTQ (Lourenço *et al.*, unpublished data).

The supplementation with SBM did not improve hay intake (P>0.55) and NDF digestibility (P=0.39). This is in agreement with previous results (Lourenço *et al*., unpublished data). Nevertheless, SBM supplementation improved total diet OM digestibility (P<0.001) and DOMI *per* kg metabolic weight (P=0.015; **Table 2**). In agreement with these results, faeces NDF digestibility was similar ($P=0.81$) between diets. Rate of NDF degradability in the rumen was slightly increased due to SBM supplementation ($P=0.06$). Supplementation increase NH_3-N concentration in the rumen ($P<0.001$; **Table 3**), as expected, but had no relevant effect on pH.

The CTQ breed exhibited higher DM and DOMI *per* kg LW ($P<0.08$) but there was no difference between breeds in intake *per* kg metabolic weight ($kg^{0.75}$ LW; $P>0.23$). The IF breed showed higher feed ($P<0.06$) and lower faeces NDF digestibility ($P<0.01$) then the local breed (***Table 2***). These results although measured in a small number of ewes, are in agreement with those observed in a previous and more extensive work with adult ewes under the same management conditions (Lourenço *et al.*, unpublished data).

There was no difference between breeds either in the pH or NH3-N ruminal fluid contents ($P>0.36$) and in DM and NDF degradation constants (($P>0.12$; ***Table 3***). Thus, the lower digestibility of the CTQ breed and its apparent high intake *per* unit of gastrointestinal capacity, assuming a linear relationship between gastrointestinal capacity and LW (Van Soest, 1994), are not a result of differences between breeds in reticulo-rumen fermentation (***Table 3***).

On the other hand, difference between breeds in ERD were observed ($P<0.01$) when the distinct rumen outflow rates of these breeds (measured in a previous trial; Lourenço *et al*., unpublished data) were taken into account (ERD_{obs}; ***Table 3***), This lead as to conclude that the higher DM intake *per* kg LW of CTQ breed and its concomitant reduced digestibility is not a result of a different rumen fermentation activity but a result of its higher rumen outflow rate.

4 - CONCLUSIONS

This study confirms that the CTQ breed is not distinct from the exotic IF breed in what concerns ruminal environmental characteristics or activity. The inherent higher outflow rate of the CTQ breed is the most likely explanation for the higher intake *per* kg LW and low digestibility of fibrous feeds she exhibits. Further research is required to identify the intake strategy characteristics of this local breed under natural environmental conditions in order to better understand its digestive physiology evolution drift.

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