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Does type of diet fed to animals affect *in sacco* degradability of feedstuffs?

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SUMMARY – Olive leaves and barley grain degradability were determined in wethers and goats. Olive leaves were incubated in the rumen of animals fed either olive leaves *ad libitum* or olive leaves supplemented with barley and faba beans. Barley grain was incubated in animals fed alfalfa hay or olive leaves supplemented with barley and faba beans. Olive leaf protein effective degradability was low (22.4 and 18.0% in goats and wethers, respectively) when animals were fed olive leaves but was increased (P<0.001) when animals received olive leaves supplemented with barley and beans (36.6 and 24.9%). The effect was mainly due to the increased (P<0.001) potentially degradable insoluble fraction. Barley grain protein effective degradability was higher (P<0.001) when incubations took place in the rumen of animals fed alfalfa hay (92.9 and 93.1% in goats and sheep, respectively) than when animals received supplemented olive leaves (82.6 and 75.1%, respectively). A similar effect was observed for soluble, and potentially degradable insoluble fraction, and degradation rate. Differences ascribed to the quality of consumed diet were more marked for protein than for dry matter degradability. Our results support the idea that if rumen degradability is used for protein evaluation of non-conventional feeds, a diet should be determined in animal feed that promotes a rumen environment appropriate for the degradation of this type of feedstuffs.

Keywords: Ruminal degradability, olive leaves, barley grain, goats, sheep, diet quality.

RESUME – *"Est-ce que le type de régime distribué aux animaux affecte la dégradabilité* in sacco *des aliments ?" La dégradabilité des feuilles d'olivier et de l'orge a été déterminée sur des moutons et des chèvres. Les feuilles d'olivier ont été incubées dans le rumen des animaux alimentés ad libitum avec des feuilles d'olivier ou des feuilles supplémentées avec de l'orge et des fèves. L'orge était incubée chez des animaux alimentés avec du foin de luzerne ou avec des feuilles d'olivier supplémentées. La dégradabilité effective de l'azote des feuilles était basse (22,4 et 18,0% chez les chèvres et les moutons, respectivement) quand les animaux mangeaient des feuilles d'olivier. Elle augmentait significativement (P<0,001) chez les animaux alimentés avec des feuilles supplémentées (36,6 et 24,9%). L'effet était associé surtout à l'augmentation (P<0,001) de la fraction insoluble potentiellement dégradable. La dégradabilité effective de l'azote de l'orge était plus haute (P<0,001) chez les animaux alimentés avec du foin de luzerne (92,9 et 93,1% pour les chèvres et les moutons, respectivement) que chez ceux alimentés avec des feuilles d'olivier supplémentées (82,6 et 75,1%, respectivement). L'effet était similaire pour les fractions soluble et insoluble et la vitesse de dégradation. Les différences associées à la qualité de l'aliment ingéré sont plus importantes pour la dégradabilité de l'azote que pour celle de la matière sèche. Nos résultats indiquent que si la dégradabilité de la protéine est utilisée pour l'évaluation protéique des aliments lignocellulosiques, les échantillons devraient être incubés dans le rumen des animaux pour que le régime alimentaire soit capable de promouvoir des conditions appropriées pour la dégradation de ce type d'aliments.*

Mots-clés : *Dégradabilité ruminale, feuilles d'olivier, orge grain, caprin, ovin, qualité du régime.*

Introduction

Rumen protein degradability is one of the most important parameters considered by the new protein evaluation systems of feedstuffs for ruminants. It determines the amino acid and ammonia N supply to ruminal microorganisms (Wallace, 1995) and, in some degree, the amino acids supply to the animal. Determination of protein degradability *in vivo* is difficult, expensive and time consuming. For those reasons most of the studies have been carried out *in sacco* and *in vitro* and degradation parameters have been estimated by following the Ørskov and McDonald (1979) model. Many authors found good correlations between *in sacco* and *in vivo* data (Stern and Satter, 1980; Madsen and Hvelplund, 1994) although low reproducibility between different laboratories has been found because of methodological reasons (Madsen and Hvelplund, 1994). The procedure establishes that animals must be fed at maintenance level with good-quality forages. However, this does not reflect the rumen

environment in case of animals fed non-conventional or poor quality forages. In this situation ammonia N and volatile fatty acid concentrations and fractional passage rate from the rumen are reduced in comparison with animals fed good quality diets. Therefore, it is of interest to know the effect of diet quality on *in sacco* protein degradability of different feedstuffs incubated in the rumen. In the present work an extensively used feed (barley grain) and a not well studied by-product (olive leaves) were incubated in animals fed two different quality diets. The effect of the animal species (goat's vs sheep) was also studied.

Material and methods

Three adult dry non-pregnant Granadina goats (43±2.1 kg LW) and three Segureña wethers (69±4.3 kg LW) were fed three experimental diets: alfalfa hay (AH), dried (room temperature) olive leaves (OL) and dried olive leaves supplemented with barley grain and faba beans (OLSUP). Diets were offered at maintenance level (AH and OLSUP) or ad libitum (OL) once in the morning and drinking water was provided *ad libitum*. Olive leaves were incubated in the rumen of sheep and goats fed either OL or OLSUP. Barley grain was incubated in the rumen of wethers and goats fed AH or OLSUP. Dried olive leaves and barley grain were mill ground through a 2 mm screen and aliquots of approximately 2 g were placed in nylon bags (7 x 10 cm and 46 µm pore) and incubated during 0, 4, 8, 16, 24, 48 and 72 h in the rumen of cannulated animals. After incubation, bags were washed in a washing machine during 20 min, then stomached for 5 min and, finally, dried at 60ºC. Aliquots of the residual dry matter (DM) were used for N analysis. The degradation parameters were calculated by the non-linear model $Dg = a + b * (1 - e^{-ct})$ described by Ørskov and McDonald (1979) where "a" is the water soluble fraction, "b" the potentially degradable (insoluble) fraction and "c" the rate of degradation of "b". The effective degradability (ED) in the rumen was calculated as $ED = a + [(b * c)/(c + k)]$, were "k" is the passage rate of the digesta, determined for each animal species and diet. Samples of OL and BG were mill ground (1 mm) and analysed for DM, OM, crude fat (CF) and total N, according to the AOAC (1984) methods; GE was determined in an adiabatic calorimeter; NDF, ADF and ADL were analysed by the sequential procedure of Van Soest and Masson (1991), using the Ankom200/220 fiber analyser (Ankom, 2000). Neutral detergent fiber was assayed with sodium sulphite and without alpha amylase. Both NDF and ADF were expressed without residual ashes.

Free (FCT), protein bound (P-CT) and fiber bound (F-CT) condensed tannins were determined in feed samples using the procedure proposed by Pérez Maldonado and Norton (1996). Condensed tannins from quebracho powder (Roy Wilson Dickson LTD, UK) were used as standard.

Data obtained were analysed by the GLM procedure of SAS (SAS Inst., Inc., Cary, NC). The model included animal species (AS), diet (D) and their interaction as fixed effects. If a value of $P<0.05$ appeared within animal species, differences among means were tested with Bonferroni t test.

Results and discussion

The ingredients composition of experimental diets is shown in Table 1. Table 2 shows the chemical composition of olive leaves and barley grain.

Table 1. Ingredients composition (g/kg fresh matter) of the experimental diets

	AH	OL	OLSUP
Alfalfa hay	975		
Olive leaves		975	700
Barley grain			200
Faba beans			75
Mineral-vitamin mixture	25	25	25

Table 2. Chemical composition (g/100 DM) of olive leaves (OL) and barley grain (BG)

	OL	BG
DM, g/100g fresh matter	93.4	91.2
Organic matter	88.1	97.5
Crude fat	8.03	1.99
Nitrogen	1.19	1.64
Neutral detergent fibre	41.8	26.3
Acid detergent fibre	28.2	6.74
Acid detergent lignin	16.7	1.32
N-ADF, g/100g total N	27.8	5.20
GE, MJ/kg DM	21.1	21.1
Condensed tannins (CT), mg/g DM		
Free CT	3.53	8.53
Fibre bound CT	6.35	0.18
Protein bound CT	1.25	2.01
Total CT	11.1	10.7

The ED of OL was low (Table 3), especially for crude protein (22.4 and 18.0%, respectively for goats and wethers). These values were lower than those reported by Martín García *et al.* (2003) due to two reasons: these authors incubated olive leaves in animals fed alfalfa hay, and olive leaves were dried at 60ºC.

Table 3. Rumen degradation parameters of olive leaves incubated in the rumen of goats and wethers fed the experimental diets

		Goats		Wethers		SEM	P level		
		OL†	OLSUP†	OL	OLSUP		AS	D	AS * D
DM	a (%)	28.2	31.9	29.2	31.6	0.210	NS	NS	NS
	b (%)	45.2^{b}	50.2^{a}	24.0^{b}	37.6^{a}	0.328	***	***	NS
	c (h^{-1})	0.014	0.016	0.001	0.002	0.001	*	NS	NS
	ED (%)	44.9^{b}	50.6^{a}	30.5^{b}	34.1^{a}	0.349	***	***	NS
CP	a (%)	12.8	17.0	14.0	15.9	0.234	NS	NS	NS
	b (%)	23.4^{b}	30.6^{a}	5.0^{b}	10.8^{a}	0.798	***	***	NS
	c (h^{-1})	0.016^{b}	0.048^{a}	0.106^{b}	0.123^{a}	0.009	**	NS	NS
	ED (%)	22.4^{b}	36.6^{a}	18.0^{b}	24.9^{a}	0.634	**	***	NS

†Diets fed: OL: olive leaves; OLSUP: olive leaves supplemented with barley grain and faba beans.
$^{a, b, c}$In the same row, for each animal species, values without a common superscript letter differ significantly (P<0.001).

In our work, in both animal species, potentially degradable fraction (b), fractional degradation rate (c) and effective rumen degradability (ED) of CP were significantly (P<0.001) higher when animals were fed supplemented olive leaves with the exception of c for DM.

The DM and CP degradabilities of barley grain (Table 4) incubated in animals fed alfalfa hay were in the range of those found by Hvelplund and Weisbjerg (1998) in cows fed silage and concentrate (60:40). When barley grain was incubated in animals fed supplemented OL there was a significant (P<0.001) decrease of a, b, c and DE. There were not significant (P>0.05) differences between goats

and sheep. These results corroborate those found in previous studies of our group (Isac *et al*., 1994; Molina Alcaide *et al*., 2000), concerning the lack of significant differences between goats and sheep, for DM and CP degradation rates and ED of medium-good quality feedstuffs.

Table 4. Rumen degradation parameters of barley grain incubated in the rumen of goats and wethers fed the experimental diets

		Goats		Wethers		SEM	P level		
		AH†	OLSUP†	AH	OLSUP		AS	D	AS * D
DM	a (%)	39.1	35.4	39.3	36.6	0.437	NS	NS	NS
	b (%)	48.9[a]	39.7[b]	50.7[a]	41.4[b]	0.551	NS	***	NS
	c (h^{-1})	0.355[a]	0.279[b]	0.312[a]	0.240[b]	0.006	NS	***	NS
	ED (%)	84.1[a]	71.6[b]	85.6[a]	74.1[b]	0.419	NS	***	NS
CP	a (%)	46.7[a]	40.6[b]	47.1[a]	36.6[b]	0.322	NS	**	NS
	b (%)	50.3[a]	45.7[b]	50.6[a]	42.8[b]	0.481	NS	***	NS
	c (h^{-1})	0.350[a]	0.304[b]	0.287[a]	0.225[b]	0.004	NS	***	NS
	ED (%)	92.9[a]	82.6[b]	93.1[a]	75.1[b]	0.509	NS	***	NS

†Diets fed: AH: Alfalfa hay; OLSUP: olive leaves, barley grain and faba beans.
[a, b, c]In the same row, for each animal species, values without a common superscript letter differ significantly ($P < 0.001$).

Conclusions

Our results support the idea that the quality of the diet offered to the animals has an important effect on rumen degradability of incubated samples, especially when lignocellulosic materials are tested. When measuring *in sacco* degradability of non-conventional feeds, rumen-cannulated animals should be fed a diet promoting a rumen environment similar to that found in animals fed these non-conventional feeds under practical conditions.

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