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Comparison of *in vitro* digestibility of feedstuffs using rumen inoculum from sheep or red deer

G. Hervás[1] M.J. Ranilla[2,3], A.R. Mantecón[1], R. Bodas[1,2] and P. Frutos[1]

[1]Estación Agrícola Experimental, Spanish Council for Scientific Research (CSIC)
Apdo 788. 24080-León, Spain
[2]Departamento de Producción Animal I. Universidad de León
24071-León, Spain

ABSTRACT

The Ankom fermentation system was used to investigate the effect of rumen fluid donor (sheep vs red deer) on *in vitro* digestibility of twelve substrates (four forages, four cereal grains and four shrubs). Dry matter and neutral-detergent fibre disappearances and *in vitro* true digestibility showed some significant differences related to the species of the rumen fluid donor, suggesting that although sheep could be used as a model to estimate *in vitro* digestibility of some conventional feeds (e.g., forages and cereal grains), important differences may be found between sheep and red deer when low-quality feeds (e.g., shrubs) are evaluated.

KEY WORDS: cereal grains, feed evaluation, forages, rumen fluid, shrubs

INTRODUCTION

Although it is known that the ultimate arbitrator of the nutritive value of any feed is the host animal, the sheep has been widely used as a model for studying the digestive functions of other ruminants. However, the development of the deer farming industry has created a demand for accurate rationing systems, especially for deer, that permit a more efficient use of the available feed resources.

Most approaches to feed characterization are intended to meet the needs of rationing systems and, because digestibility is the principal cause of variation of the metabolizable energy content, the energy value of feeds is commonly predicted from *in vitro* estimates of digestibility. Over other *in vitro* techniques, the Ankom fermentation system presents the advantages of reducing labour costs and being able to analyse a high number of samples at once.

With the increased use of *in vitro* techniques to evaluate ruminant feedingstuffs, it is of great importance to identify whether the species from which the rumen

[3] Corresponding author: e-mail: dp1mrg@unileon.es

fluid inoculum is obtained has a significant influence on the results obtained. This trial was carried out to determine the influence of rumen fluid donor (sheep vs red deer) on *in vitro* digestibility of several substrates.

MATERIAL AND METHODS

Four forages (lucerne hay, barley straw, maize silage and beet pulp), four cereal grains (barley, maize, sorghum and wheat) and four shrubs (*Calluna vulgaris, Erica australis, Cytisus cantabricus and Genista occidentalis*) were selected as substrates to cover a wide range of chemical compositions (see Table 1).

Table 1. Chemical composition of the feeds used for *in vitro* incubations[1], g/kg DM

Feeds	OM	CP	NDF	ADF	ADL
Forages					
lucerne hay	921	152	462	334	67
barley straw	931	51	759	423	28
maize silage	954	76	340	168	0
beet pulp	936	88	445	230	10
Cereal grains					
barley	978	113	189	45	n.d.
maize	987	76	111	21	n.d.
sorghum	985	97	80	22	n.d.
wheat	985	99	117	27	n.d.
Shrubs					
Calluna vulgaris	972	60	491	334	160
Erica australis	981	60	486	347	142
Cytisus cantabricus	963	213	415	260	63
Genista occidentalis	944	209	307	209	58

[1] DM - dry matter; OM - organic matter; CP - crude protein; NDF - neutral-detergent fibre; ADF - acid-detergent fibre; ADL - acid-detergent lignin; n.d. - non-determined

Four Merino sheep (48±2.1 kg; *Ovis aries*) fitted with ruminal cannulae and four red deer (76±1.4 kg; *Cervus elaphus*) belonging to the flocks of the CSIC (León, Spain) were used. Animals were fed lucerne hay (20 g kg LW^{-1} day^{-1}) and barley grain (3 g kg LW^{-1} day^{-1}), for a 15-day period before collecting the rumen fluid for the *in vitro* incubations.

Incubations were carried out using the Ankom *in vitro* fermentation system Daisy^{II} (Ankom Technology, Macedon, NY, USA). Two rumen inocula were obtained from each species (through ruminal cannula from sheep and immediately after slaughter from deer). Rumen fluids were collected into pre-warmed thermo flasks, taken immediately to the laboratory, stained through four layers of cheesecloth and diluted into the reduced buffer medium (Goering and Van Soest, 1970) in the proportion 1:4 (v/v). Ground

feed samples (≈500 mg milled at 1 mm) were weighed into Ankom filter bags (F57, Ankom Technology, Macedon, NY, USA), heat sealed and placed in the incubation jars. Each jar was filled with 24 bags (2 bags per substrate) and 2 L of buffered rumen fluid dispensed under CO_2 and then deposited in the rotating incubator at 39ºC. After 48 h, the bags were gently rinsed in cold water, dried and weighed to determinate dry matter disappearance (DMD). They were then treated with a boiling neutral detergent solution for 1 h using an Ankom^{200} fibre analyser (Ankom Technology, Macedon, NY, USA), washed with distilled water, dried and weighed to determine both neutral-detergent fibre disappearance (NDFD) and *in vitro* true digestibility (ivTD).

Procedures described by AOAC (1995) were used to determine dry matter (DM), ash and Kjeldahl nitrogen. Neutral-detergent fibre (NDF), acid-detergent fibre (ADF) and acid-detergent lignin (ADL) were determined by the methods of Goering and Van Soest (1970) and Van Soest et al. (1991).

One-way analysis of variance using the general linear model (GLM) procedure of the SAS package (SAS, 1999) was utilized to compare the differences between animal species (sheep and red deer) for each substrate.

RESULTS AND DISCUSSION

Values of DMD, NDFD and ivTD (Table 2) showed not only the expected variation depending on the substrate incubated but also some significant differences related to the species of the rumen inoculum donor (sheep vs deer).

Table 2. Dry matter (DMD; g/kg) and neutral-detergent fibre (NDFD; g/kg) disappearances and *in vitro* true digestibility (ivTD; g/kg) of different substrates incubated with rumen inoculum from sheep or red deer

Feeds	DMD			NDFD			ivTD		
	sheep	deer	sed[1]	sheep	deer	sed	sheep	deer	sed
Forages									
lucerne hay	663^{a}	642^{b}	3.2	408^{a}	385^{b}	7.5	727^{a}	716^{b}	3.5
barley straw	617^{a}	587^{b}	5.3	565^{a}	530^{b}	5.9	670^{a}	643^{b}	4.5
maize silage	880^{a}	862^{b}	2.5	719^{a}	691^{b}	9.8	904^{a}	895^{b}	3.3
beet pulp	932	930	4.3	909	902	4.5	960	956	2.0
Cereal grains									
barley	881	890	4.4	605^{b}	638^{a}	11.9	925^{b}	932^{a}	2.3
maize	933	924	3.8	849	866	14.6	984	985	1.6
sorghum	928	913	6.4	912	904	22.3	993	992	1.8
wheat	919	925	2.6	549^{b}	593^{a}	12.7	947^{b}	953^{a}	1.5
Shrubs									
Calluna vulgaris	592^{a}	480^{b}	12.1	359^{a}	230^{b}	27.9	686^{a}	622^{b}	13.6
Erica australis	341	351	6.6	11^{b}	21^{a}	3.5	516^{b}	525^{a}	1.9
Cytisus cantabricus	733^{b}	773^{a}	8.7	485^{b}	564^{a}	10.4	786^{b}	819^{a}	4.3
Genista occidentalis	826	827	23.0	638	640	46.9	889	889	14.4

[1] sed - standard error of the difference (n=4); ^{a,b} for each parameter, means with different superscripts within one row differ significantly ($P<0.05$)

DM disappearance was higher ($P<0.05$) for three forages (lucerne hay, barley straw and maize silage) and for *Calluna vulgaris*, and lower ($P<0.05$) for *Cytisus cantabricus* when incubated with rumen inoculum obtained from sheep. Statistical differences between ruminant species showed the same behaviour for values of NDFD and ivTD. Thus, these were greater ($P<0.05$) in sheep for the same three forages above mentioned and for *Calluna vulgaris*. Deer, however, seemed to be better able to digest barley and wheat grains and *Erica australis* and *Cytisus cantabricus* ($P<0.05$).

As proportionate increases, the highest differences were observed for the disappearance of NDF and for incubations of low-quality feedstuffs (shrub species). On the other hand, differences between sheep and deer for ivTD of forages and cereal grains were never higher than 4.2%.

The difficulty of generalizing about the digestion capacity of sheep and deer imposed by the interaction between animal species and feed ingredients has been pointed out in the literature (Ru et al., 2002). Comparisons of digestion by sheep and deer have resulted in differences in favour of the sheep, in favour of the deer, or even no differences depending on the feedstuff studied (Milne et al., 1978; Domingue et al., 1991; Gordon et al., 2002).

CONCLUSIONS

These results suggest that sheep could be used as a model to estimate *in vitro* digestibility, using the Ankom fermentation system, of conventional feeds (e.g., forages and cereal grains) for rationing for deer. However, important differences may be found between sheep and red deer when non-conventional low-quality feeds (e.g., shrubs) are evaluated.

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