

# Apparent digestibility of mixed diets in horses determined by acid-insoluble ash and acid detergent lignin as internal markers

Ana Sophia Santos<sup>1</sup>, José M. Abreu<sup>2</sup>  
and Arnaldo A. Dias-da-Silva<sup>3</sup>

Department of Veterinary, Esc. Univ. Vasco da Gama, Quinta de S. Jorge, Castelo Viegas, Coimbra<sup>1</sup>, CECA, Faculdade de Ciencias, Universidade do Porto<sup>2</sup> and CECAV – Department of Animal Science, Univ. de Trás-os-Montes e Alto Douro<sup>3</sup>, Portugal

## Introduction

In recent years there has been an increasing interest for horses in more developed countries for leisure and sport purposes which brought a new dynamic to the knowledge of horse nutrition. Most of the times, sport horses are fed on an individual basis. Therefore, the knowledge of the nutritional value of the feedstuffs offered to them is crucial.

The experimental digestibility of feeds or diets can be measured or estimated by several techniques. The *in vivo* methods are generally more precise and allow the study of digestibility under different metabolic conditions, thus giving more detailed information (Miraglia et al. 1999). Nevertheless, they require a number relatively large of animals, are more laborious and expensive.

The use of internal markers, as alternative to the total faeces collection method, is quite attractive because it easily adapted to field conditions, avoid the laborious collection of total faeces and the need to add the marker to the diet.

The use of acid insoluble ash (AIA) as an internal marker has been shown to be a successfully method in horses (Miraglia et al. 1999, Araújo et al. 2000, Bergero et al. 2004). Acid detergent lignin (ADL) has been also used as internal marker in horse digestibility studies, but with controversial results (Wolter et al. 1979, Miraglia et al. 1999).

The aim of the present study was to estimate the digestibility of two diets (forage plus concentrate) using AIA and ADL as internal markers.

## Materials and methods

Five adult horses were used in two digestibility trials. In the absence of facilities for weighting the horses, the body weight of the different animals was estimated to range between 370 and 500 kg (Martin-Rosset 1990). The horses were kept in individual stalls with a daily renewed wood shavings litter. The animals were fed 6 kg meadow hay (Trial 1) or oat straw (Tri-

al 2) supplemented with 3 kg of an oat and faba bean mixture (50:50 on a dry matter basis). This implied that the energy feeding level ranged from 0.9 to 1.3 of the maintenance requirements (NRC, 1989). The animals were fed three times a day at 08.00, 12.00 and 20.00 hours, with equal meals of forage and concentrate. There were no refusals. Feed and faeces samples were collected daily over a period of seven days after a fourteen-day period of adaptation to the diet, according to the proposed methodology by Martin-Rosset et al. (1984). The faeces were collected by grab sampling in alternate periods of 12 and 18 hours. This schedule was adopted to avoid rectum injuries.

After collection, samples of feeds and faeces were dried in a forced-air oven at 65°C for at least 24h for DM determination. Feeds and faeces were then ground to pass 1 mm screen and analyzed for ash, ether extract and Kjeldhal – N (AOAC, 1990), for neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) as described by van Soest et al. (1991) and for acid insoluble ash (AIA) according to Van Keulen and Young (1977). Crude protein (CP) was calculated as Kjeldhal-N x 6.25.

## Results

The chemical composition of the feeds used are summarised in Table 1. Meadow hay and oat straw can be described as being mid and low quality feeds, respectively. The chemical composition of these roughages can be considered similar to those commonly found in stables all over the north of Portugal. Digestibility coefficients for the two diets, estimated using AIA or ADL as internal markers, are summarised in Table 2.

**Table 1** Chemical composition of feeds (mean ± SD; g/kg<sup>-1</sup> DM).

	Meadow hay	Oat straw	Concentrate
Dry matter	871 ± 1.5	892 ± 0.5	897 ± 1.7
Organic matter	909 ± 6.8	935 ± 5.8	969 ± 0.5
NDF*	692 ± 19.4	823 ± 22.2	336 ± 12.8
ADF*	415 ± 13.7	536 ± 14.1	180 ± 6.2
ADL*	56.6 ± 2.6	81.1 ± 3.7	48.0 ± 4.6
Crude protein	75.4 ± 6.4	36.6 ± 2.8	175 ± 4.5
Ether extract	8.6 ± 1.3	9.7 ± 1.4	34.8 ± 3.2
AIA	25.5 ± 2.9	13.3 ± 1.7	5.1 ± 0.1

\*NDF: neutral detergent fibre, ADF: acid detergent fibre, ADL: acid detergent lignin, AIA: acid-insoluble ash

**Table 2** Apparent digestibility (%) of meadow hay and oat straw diets, using acid insoluble ash and acid detergent lignin as internal markers.

	Acid insoluble ash		Acid detergent lignin	
	meadow hay	oat straw	meadow hay	oat straw
DM*	56.4 <sup>a</sup> ± 4.1	44.1 <sup>b</sup> ± 1.1	56.2 <sup>a</sup> ± 1.3	43.1 <sup>b</sup> ± 1.7
OM*	56.7 <sup>a</sup> ± 4.1	43.2 <sup>b</sup> ± 1.3	56.2 <sup>a</sup> ± 1.27	47.2 <sup>b</sup> ± 2.6
NDF*	42.9 <sup>a</sup> ± 5.5	30.9 <sup>b</sup> ± 1.8	42.7 <sup>a</sup> ± 1.4	29.8 <sup>b</sup> ± 3.4
ADF*	39.9 <sup>a</sup> ± 5.6	29.9 <sup>b</sup> ± 1.8	34.8 <sup>a</sup> ± 1.5	25.6 <sup>b</sup> ± 2.5
CP*	66.4 <sup>a</sup> ± 4.2	57.8 <sup>b</sup> ± 2.1	66.3 <sup>a</sup> ± 1.6	57.1 <sup>b</sup> ± 1.6

\*DM: dry matter; OM: organic matter; NDF: neutral detergent fibre, ADF: acid detergent fibre, CP: crude protein

<sup>ab</sup>Means with different superscript differed for P < 0.05

## Discussion

There were no differences (P > 0.05) between digestibility coefficients estimated by AIA or by ADL. This contrasts with

the findings of Miraglia et al. (1999) and Araújo et al. (2000) who reported digestibility coefficients systematically lower with ADL as internal marker than with AIA or with total faeces collection. According to those authors the lack of recovery of ADL they observed in faeces may explain their findings. In the present study it was assumed that the recovery of the internal markers was 100%. However, this could not have been the case. The digestibility values of meadow hay and oat straw diets obtained with AIA were close to those reported by Cuddeford and Hughes (1990), Miraglia et al. (1999) and Araújo et al. (2000) for similar diets.

## Conclusions

Ideally the nutritive value of any feed offered to horses should be estimated by simple methods that do not introduce changes to the normal digestive function of the animal. Our results show that the use of AIA and ADL as internal markers are promising in estimating the digestibility of diets, giving figures that are statistically the same. This means that either markers are affected by the same error or that they are, in fact, good estimators. In this case these markers could be a good choice under field conditions.

## Acknowledgements

The authors thank the help of Ana Lourenço in writing the manuscript.

## References

- AAOAC (1990): Official Methods of Analysis, 14th Edition, Vol. 1 AOAC, Washington DC, USA, 684
- Araújo K. V., Lima J. A. F., Fialho E. T. and Miyagi E. S. (2000): Comparação dos indicadores internos com o método de coleta total para determinar a digestibilidade dos nutrientes de dietas mistas em equinos. *Ciências Agrotecnicas* 24, 1041-1048
- Bergero D., Miraglia N., Abba C. and Polidori M. (2004): Apparent digestibility of mediterranean forages determined by total collection of faeces and acid-insoluble ash as internal marker. *Livestock Production Science* 84, 235-238
- Cuddeford D. and Hughes D. (1990): A comparison between chromium-mordanted hay and acid insoluble-ash to determine apparent digestibility of a chaffed, molassed hay/straw mixture. *Equine Veterinary Journal* 22, 122-125
- Martin-Rosset W., Andrieu J., Vermorel M. and Dulphy J. P. (1984): Valeur nutritive des aliments pour le cheval, In : Jarrige, J. e Martin-Rosset, W. (Ed), *Le Cheval – Reproduction, sélection, Alimentation, Exploitation*. INRA Publications, Versailles
- Martin-Rosset W. (1990): *L'Alimentation des chevaux*. Institut National de la Recherche Agronomique, Paris
- Miraglia N., Bergero D., Bassano B., Tarantola M. and Ladetto G. (1999): Studies of apparent digestibility in horses and the use of internal markers. *Livestock Production Science* 60, 21-25
- National Research Council (NRC), *Nutrient Requirements of Domestic Animals*. n° 6 *Nutrient Requirements of Horses*, 5th revised edition. National Academy of Sciences, Washington D.C.
- Van Keulen J. and Young B. A. (1977): Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility studies. *Journal of Animal Science* 44 (2), 282-287
- Walter R., Durix A., Letourneau J. C. and Carcelen M. (1979): Évaluation chez le poney de la digestibilité du maïs-fourrage désidraté, des pulpes sèches de betterave, de la luzerne désydraté, du son de blé, de la paille de blé et des pulpes de raisins. *Annales de Zootechnie* 28 (1), 93-100
- A. S. Santos  
Department of Veterinary,  
Esc. Univ. Vasco da Gama  
Quinta de S. Jorge  
Estrada da Conraria  
3040-714 Castelo Viegas, Coimbra  
Portugal  
assantos@utad.pt