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The effects of a new fibre-rich concentrate on the digestibility of horse rations

N. Miraglia [a], D. Bergero [b,*], M. Polidori [a], P.G. Peiretti [c], G. Ladetto [b]

[a] *Dipartimento di Scienze Animali, Vegetali e dell'Ambiente, University of Molise, Via De Sanctis, 86100 Campobasso, Italy*
[b] *Dipartimento di Produzioni Animali, Epidemiologia ed Ecologia, University of Turin, Via L. da Vinci 44, 10095 Grugliasco (Torino), Italy*
[c] *Istituto di Scienze delle Produzioni Alimentari, National Research Council, Via L. da Vinci 44, 10095 Grugliasco (Torino), Italy*

Abstract

Commercially mixed feeds for light horse feeding are being used more and more and, in recent times, a particular role has been played by mixed feeds characterized by high fibre percentages together with pre-biotic or pro-biotic supplements. Consequently, more data about these new feeds are required. The apparent digestibility of a commercially mixed feed containing about 14% crude fibre (CF) as a feed and 1% lactulose was determined by means of 3 in vivo digestibility trials each performed on 4 saddle horses weighting about 550 kg over a 6 day faeces total collection period with a previous 14 day adaptation period. The diets were based on first cut meadow hay – whose digestibility was estimated in the first trial – and a mixed feed at a feeding level close to maintenance. The forage to concentrate ratios were 100 : 0, 75 : 25 and 50 : 50, respectively, in the three trials. The apparent digestibility of the dry matter, organic matter, gross energy, crude protein, NDF, ADF and CF were measured by the *ingesta*/*excreta* procedure. The data was processed using ANOVA. Significant differences were only found for the concentrate in the apparent digestibility coefficients of the dry matter (P=0.021), gross energy (P=0.023), ADF (P=0.041), NDF (P=0.006) and cellulose (P=0.031).

Keywords: Horse; Apparent digestibility; Concentrate; Fibre

1. Introduction

The market for horse feedstuffs is no longer based on traditional feeds, such as cereals or legume seeds; more and more complex commercial compound feeds are now available for different purposes. These new feeds are no longer based on the containment of manufacturing costs: they are increasingly more formulated on the basis of nutritional correctness and for the correct management of the hindgut bacteria population. In particular, in recent times, commercial concentrates that are rich in "dietetic fibre" or simply "high fibre concentrates" have been proposed to prevent stomach and gut problems, in particular for horses involved in sports that suffer from high stress

* Corresponding author. Tel.: +39 11 6709207; fax: +39 11 6709240.
E-mail address: domenico.bergero@unito.it (D. Bergero).

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levels. The use of less “starchy” concentrates is also advisable for growing horses, to prevent the onset of developmental orthopaedic diseases. More data is needed, however, to assess the effect of these products on the utilisation of the whole ration. Many factors, related to the feedstuff itself or external conditions, can in fact influence the digestive functions of horses (Orton et al., 1985; Bergero et al., 1998).

The aim of this work was to comparatively assess the apparent digestibility of rations that include increasing levels of a new concentrate which is rich in fibre sources, by performing three “in vivo” digestibility trials that differ according to the forage/concentrate ratios.

2. Materials and methods

Three in vivo digestibility trials have been performed on 4 saddle horses, weighting 553.5 ± 28.9 kg. The horses were fed, in all the trials, at a feeding level that was near maintenance. In the first trial, first cut meadow hay was given as the only feedstuff, while in the second trial the same hay was used together with a commercially mixed feed, at a forage to concentrate ratio (FCR) of 75/25 on a dry matter basis. In the last trial the same feedstuff was again used, but this time the forage to concentrate ratio was 50/50. The compositions of the feedstuffs used in the different trials are reported in Table 1.

Table 1
Chemical composition (on DM basis) and gross energy (GE) of the hay and concentrate in the different trials

	Hay trial 1	Hay trial 2	Hay trial 3	Concentrate trial 2	Concentrate trial 3
Dry matter	88.2	89.2	87.5	87.4	88.2
Organic matter	94.4	94.2	94.2	92.6	92.0
Ash	5.6	5.8	5.8	7.4	8.0
Crude protein	8.1	8.1	7.7	12.0	12.8
Crude fibre	37.5	39.0	39.0	14.0	14.0
NDF[a]	61.7	60.1	62.0	28.7	27.5
ADF[b]	38.3	37.9	38.4	16.9	16.1
ADL[c]	5.1	5.5	5.4	4.9	4.7
NFE+EE[d]	48.8	47.1	47.5	66.6	65.2
GE (MJ/kg)	18.9	18.5	18.6	17.9	17.8

[a] Neutral detergent fibre.
[b] Acid detergent fibre.
[c] Acid detergent lignin.
[d] Nitrogen-free extracts + ether extract.

The ingredients of the commercially mixed feed are listed below, in decreasing order according to weight: citrus pulp, maize, barley, soybean meal, steam flaked wheat, carob pulp, cane molasses, hydrated di-calcium phosphate, mineral premix (Ran-Jet ACME®), live yeast, calcium carbonate, sodium chloride, soybean oil, acidifying agent, essential aminoacidic supplement (It-Is ACME®), microminerals supplement (Osteparon ACME®), and lactulose (10 g/kg).

The experimental period lasted 20 days for each trial: 14 days of adaptation to the diet and 6 days of total faeces collection, according to Martin-Rosset et al. (1984), using a suitable device (Horse Diaper) that allows the complete recovery of the faeces (and the urines, if required, in separate bags) and avoids the forced reclusion of the horses in digestibility stalls thus allowing the horses to walk and roam around freely. The horses were individually stabled in boxes with free access to water.

The faecal samples were dried in a forced-draft oven at 100 °C for 1 h and after that at 60° to constant weight and then ground in a Cyclotec mill (Tecator, Herndon, VA, USA) to pass a 1 mm screen. Feed samples were taken for immediate determination of the dry matter content at 80 °C, then they were air equilibrated, weighted, ground and stored for later analyses.

The faeces and dried feed samples were analysed to determine the crude protein (CP), crude fibre (CF), and ash, according to AOAC (1990). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined according to Van Soest et al. (1991). The gross energy (GE) was measured with an adiabatic calorimeter bomb (IKA C7000, Staufen, Germany). The nitrogen-free extract plus ether extract (NFE+EE) and organic matter (OM) were calculated for each material on the basis of the previous data. The cellulose and hemicellulose were calculated from the NDF, ADF and ADL.

The apparent digestibility coefficients (ADC) of the hay and rations were then calculated using the previous data; the same parameters were also calculated from the digestibility coefficients of the hay and the rations. The ADC data of the rations and the concentrate was processed using one-way analysis of variance (ANOVA), with the trials being the only

Table 2
Mean and S.E. of the apparent digestibility coefficients of the hay, rations and concentrate

	Hay trial 1	Ration trial 2	Ration trial 3	Concentrate trial 2	Concentrate trial 3
Dry matter	56.7 ± 4.3	57.4 ± 2.4	61.2 ± 1.3	47.3 ± 3.1	65.7 ± 4.1
Organic matter	56.4 ± 3.8	58.3 ± 2.3	62.8 ± 1.2	53.2 ± 6.0	69.2 ± 3.7
GE	54.5 ± 4.3	54.7 ± 2.4	58.3 ± 1.1	43.3 ± 3.4	62.0 ± 4.2
Crude protein	57.5 ± 3.1	57.6 ± 3.8	60.4 ± 2.6	54.3 ± 8.6	63.3 ± 4.4
Crude fibre	43.0 ± 4.2	33.5 ± 3.9	33.3 ± 3.2	− 5.2 ± 24.4	23.6 ± 4.6
Cellulose	56.5 ± 9.2	43.7 ± 2.5	56.8 ± 3.7	− 17.2 ± 21.8	57.1 ± 14.4
Hemicellulose	63.0 ± 4.1	58.2 ± 4.4	59.9 ± 1.4	32.0 ± 14.1	56.8 ± 5.2
NDF	50.7 ± 6.5	42.4 ± 2.2	43.0 ± 1.9	− 0.5 ± 4.7	35.2 ± 5.7
ADF	43.2 ± 8.0	33.0 ± 3.0	32.1 ± 2.3	− 20.0 ± 15.8	20.9 ± 6.0

comparison factor, using the SPSS statistics package. The groups were compared using the Least Significant Difference (LSD) Test (Norusis, 1992).

3. Results

In the second trial, one horse was taken off the experiment, due to health problems. The apparent digestibility coefficients obtained in the present work are summarized in Table 2. Significant differences were only found for the concentrate in the ADCs of the dry matter ($P=0.021$), gross energy ($P=0.023$), ADF ($P=0.041$), NDF ($P=0.006$) and cellulose ($P=0.031$); the organic matter ADC showed a significance level that was slightly above the upper limit ($P=0.061$). As expected, the mean trends of the rations show an increase in the digestibility coefficients of the dry matter, organic matter, gross energy and crude protein whit an increase in the concentrate percentages. On the contrary, a mean decrease was obtained for the digestibility coefficients of the crude fibre, cellulose, hemicellulose, NDF and ADF by adding the concentrate to the diet. This decrease, however, can be considered more important for the crude fibre (about 9 points less) than for the hemicellulose (about 3–4 points less). This is in accordance with the data provided by Pagan (1998) about the digestibility of early or late cut alfalfa hay. On the basis of the obtained data, we calculated some simple mathematical equations (Table 3), to determine the dry matter, organic matter, gross energy and crude protein ADCs of the concentrate for all the percentages of inclusion in the diet. In all cases the regression coefficients obtained were very low and the standard error of the mean was about 5 points.

Table 3
Regression equations for the estimation of the apparent digestibility coefficients of the concentrate alone obtained by extrapolation with the relevant correlation coefficients and standard errors of estimation (x=% of concentrate in the diet)

	r^2	SEE
DMD[a] = 56.30 + 0.089 x	0.123	5.62
OMD[b] = 56.03 + 0.129 x	0.270	4.98
GED[c] = 54.08 + 0.075 x	0.092	5.54
CPD[d] = 57.11 + 0.058 x	0.056	5.63

[a] Dry matter digestibility.
[b] Organic matter digestibility.
[c] Gross energy digestibility.
[d] Crude protein digestibility.

4. Discussion and conclusions

The use of the new concentrate, as expected, slightly increased the average digestibility coefficient of the rations for the main parameters: dry and organic matter, gross energy, and crude protein. This is in accordance with the general improvement of the rations, in terms of valuable nutrients. The steady overall digestibility coefficient of the hemicellulose is also very interesting. This can be explained as being the consequence of the good fibre sources used in the concentrate formulation. The main ingredient of the latter is citrus pulp, a valuable digestible fibre source. Moreover, generally speaking, the use of starchy concentrates decreases fibre digestibility, but this new formula, because of its different balance between fibre and energy, seems to be more suitable for the functionality of the horses' large intestine. Deeper studies seem however to be advisable in this matter.

The concentrate ADCs were calculated and not obtained straight from field measurements: for this reason, they do not seem to be properly evaluated; the upper inclusion level, as expected, seems to increase the efficacy of the concentrate digestion. In particular, the dry matter, organic matter, gross energy and crude protein concentrate ADCs are higher in the 50/50 ration; the negative results observed for the concentrate fibre fractions in the ADCs for the 75/25 ration are the result of interactions that, for these calculations, cannot be taken into due account and which play a great role in producing conflicting effects. The high ADC of hemicellulose of the concentrate for both rations should be mentioned, because it confirms the good fibre quality of the concentrate itself. The problem of interaction has already been pointed out by Martin-Rosset and Dulphy (1987), and it requires further research, in particular for new concentrates that are rich in fibre.

The regression equations highlight a similar problem: for all the studied ADCs, the regression coefficients are very low and the standard error of the mean is about 5 points, thus showing it has no use in either field applications or in the research area. Further studies are necessary, but it seems that the intrinsic limits of these digestibility trials do not permit the coefficients to be processed and manipulated, without problems of interference.

This study points out that the new fibre-rich concentrates for horses should be considered, in terms of digestibility, as feedstuffs that are different from traditional cereals and seeds, and their role is very important for complete utilisation of the ration. More research is still necessary to identify the limits of the use of digestibility trials to determine the ADCs of concentrates rich in new fibre sources.

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