Estimation of digestible energy in horse diets using an in vitro method

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Introduction

The content of digestible energy (DE) in horse feed can be estimated, on principal, by regression equations based on chemical-analytical parameters of the feed (*Zeyner* 1995, *Zeyner* and *Kienzle* 2002) or patterns of simulated digestion (*Applegate* and *Hershberger* 1969, *Sunvold* et al. 1995, *Macheboeuf* and *Jestin* 1997, *Macheboeuf* et al. 1997, *Lowman* et al. 1999, *Moore-Colyer* and *Longland* 2000, *Moore-Colyer* et al. 2003, *Murray* et al. 2003, *Hayes* et al. 2003, *Lattimer* et al. 2005, *Ringler* et al. 2005ab, *Turcott* et al. 2005, *Warren* and *Kivipelto* 2005). As to the latter, a method that exists in slight variations works by incubation with pepsin and cellulase. Until know it is successfully used to estimate the amount of digestible organic matter in forages for ruminants (*Nousiainen* et al. 2003), but has never been tested to value horse feed. This study was conducted to prove the fitness of in vivo determined pepsin-cellulase indigestible organic matter (OMid) to estimate the DE content of horse diets with a comparably high variation in fibre content and quality while in vivo results act as control.

Material and methods

Nine digestion trials with fife adult horses were conducted to determine the DE content of diets composed of oats, maize, grass hay and straw, respectively, in vivo (*Zeyner* et al. 1992). The proximate nutrients varied as follows (in % of the dry matter, DM): crude ash, 3.0-8.8; crude protein, 6.3-12.3; acid ether extract, 2.7-3.4; crude fibre, 17.9-27.8; nitrogen free extract, 44.4-67.9; neutral detergent fibre (NDF), 38.8-53.3; acid detergent fibre (ADF), 21.3- 36.4; acid detergent lignin (ADL), 2.4-5.6. Between 10.2 and 16.5% of the ADF were found to be ADL. For in vitro investigations, the pepsin-cellulase method by *Nehring* (1979) in a modification according to *Friedel* (1990) was used to measure the amount of OMid in the feed. The qualification of in vitro OMid alone or in touch with different nutrient fractions was proved to estimate the DE content of the diets regressively by use of SPSS 11.0 (SPSS Inc., Chicago, Illinois, USA).

Results

In vivo DE as well as in vivo and in vitro OMid in the DM of the diets varied from 10.1 to 13.5 MJ as well as 203 to 438 and 126 to 397 g, respectively. In this way, mean in vitro OMid was clearly lower than the parallel in vivo result. Nevertheless, in vivo and in vitro OMid were highly linearly related (Fig. 1). The slope of the regression equation to estimate in vivo from in vitro OMid lied below 1 in the manner that the difference between results from both methods was the higher the lower the OMid was. The DE content (y, in MJ/kg DM) was valuable from in vitro OMid (x_1, in g/kg DM) by the following equation: $y=14.79-0.013\,x_1$ ($R^2=0.810$, $P < 0.001$). The mean difference between the measured and regressively estimated energy content (lΔl) amounted to 0.45±0.35 MJ DE/kg DM. The best estimation could be obtained by further inclusion of the cell content (CC) of the feed (x_2, in g/kg DM) as independent factor which was defined as organic matter minus NDF (*Zeyner* 1995): $y=12.50-0.012x_1 + 0.004\,x_2$ ($R^2=0.882$, $P < 0.001$). In this way, lΔl was reduced to 0.39±0.34 MJ DE/kg DM.

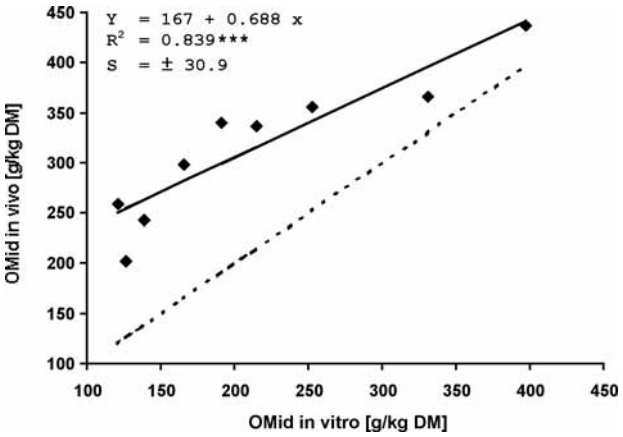

Fig 1 Relation between the content of in vivo and in vitro determined indigestible organic matter (OMid) in the experimental diets.

Discussion

In the recent study, the number of experimental diets available to compare in vivo and in vitro results was clearly limited, but the chosen diets were highly variable regarding the content of fibre and it's quality, measured as degree of lignification. The content of highly digestible nutrients, except fat, varied notably too. Within this inhomogenous material, pepsin-cellulase OMid allowed, on principle, to create acceptable regression equations to estimate the DE content of the diets. However, in vivo and in vitro OMid were linearly but not strongly parallel related and therefore in vitro OMid and in vivo DE, too. This may be why the digestibility of soluble carbohydrates as a main part of the CC can not be covered by the pepsin-cellulase method. This causes the need for a correction, particularly for diets with a low content of OMid which are in most cases especially high in CC. Fortunately, the digestible fraction of CC depends linearly positively from the dietary CC content itself (*Zeyner* 1995). Thus, a regression equation to estimate the dietary DE content that additionally includes CC as independent factor fits better. Based on the in vitro applied enzymes, the application of such an equation is strongly limited to diets with native amounts of fat.

Conclusions

In vitro determined OMid in the feed seems to be suitable to estimate the DE content of diets with native fat contents regressively. The further inclusion of the dietary CC content as independent factor increases the security of the target function.

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