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Intake and apparent digestibility of hay or hay plus concentrate diets determined in horses by the total collection of feces and *n*-alkanes as internal markers

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Abstract

The apparent digestibility of hays plus two commercial mixed feeds containing about 14% and 11.8% crude fiber (CF), respectively as feeds was determined by means of two *in vivo* digestibility trials, each performed on 4 or 5 saddle horses weighing on average about 550 and 535 kg, respectively, over a 6 day feces total collection period with a previous 14 day adaptation period. The diets were based on a first cut meadow hay – whose digestibility was estimated in each trial – and different percentages of the mixed feeds at a feeding level close to maintenance. The two mixed feeds were rich respectively in a by-product from the citrus fruit industry (citrus pulp) and in a by-product from the apple fruit industry (apple pectin pulp). The forage to concentrate ratio was, respectively, 50:50, 75:25 and 100:0 on a dry matter basis (Diets 1, 2 and 3) in the first trial and, 50:50 and 100:0 (Diets 4 and 5) in the second trial.

The apparent digestibility of the dry matter, organic matter, gross energy, and crude protein was measured by the ingesta/excreta procedure and using the most abundant *n*-alkanes (C₂₇, C₂₉, and C₃₁) as internal markers for all the rations and the hays.

No differences were found among the digestibility coefficients obtained by the total collection method or using the different *n*-alkanes.

The use of *n*-alkanes for digestibility determinations in horses is neither precise nor accurate, but can be advised for free ranging animals, when the total collection of feces is impossible. Taking into account that the accuracy of this later method is comparable, we suggest selecting *n*-alkanes with a high concentration and the highest fecal recovery; C₂₉ and C₃₁ *n*-alkanes (the first in particular) resulted to be the best choice.

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1. Introduction

The digestibility of horse feeds and rations can be determined using different techniques: calculations based on the chemical composition of feeds, *in vivo* or *in vitro* methods. Indirect methods using external and internal markers have been developed (Kotb and Luckey, 1972; Holland et al., 1998; Lippke, 2002). Several internal markers, such as acid insoluble ash, lignin and indigestible detergent fibers have been the most frequently used internal markers in equine studies; however, none of these markers exhibit the characteristics of an ideal internal marker (Sutton et al., 1977; Cuddeford and Hughes, 1990; Miraglia et al., 1999; Bergero et al., 2004, 2005), even though acid insoluble ash seems to be the best choice (Miraglia et al., 1999; Sales and Janssens, 2003; Zeyner et al., 2003). Variations in the recovery of markers have been a distinct disadvantage of many of these techniques.

Plant waxes often contain *n*-alkanes in considerable quantities (Tulloch, 1976). This offers the opportunity of using them as internal markers. An alternative method based on the analysis of plant *n*-alkanes in herbage and feces has already been used to estimate dry matter intake and digestibility in horses (McLean et al., 1996; Gudmundsson and Thorhallsdottir, 1998; Ordakowski et al., 2001) and in ruminants (Mayes and Lamb, 1984; Mayes et al., 1986; Dove and Coombe, 1992; Dove and Mayes, 1996; Dove et al., 1999). The surface wax of most higher plants contains mixtures of saturated straight-chain hydrocarbons, with a chain length ranging from 21 to 35 carbons (Dove and Mayes, 1996). The *n*-alkanes with odd-number carbon chains predominate (>90%) and the relative levels and patterns of *n*-alkane components differ among the herbal species (Dove and Mayes, 1991), with most herbage species tending to have mainly odd-chain *n*-alkanes in the range of C₂₉ to C₃₃, whereas in many trees and browse species the shorter-chain *n*-alkanes predominate.

In horses, ponies and pigs, the recovery of *n*-alkanes proved in previous researches to be independent of the chain length (Mayes et al., 1995). O'Keefe and McMeniman (1998) showed that the recoveries of odd-chain *n*-alkanes in the range of C₂₅ to C₃₃ in horses were similar in chain length classes and were higher than the recovery rates reported for

ruminants, where fecal recovery of *n*-alkanes increased with increasing chain length (Mayes and Lamb, 1984; Mayes et al., 1986). A 100% recovery is not easy to obtain, due to the accuracy level of the method.

The aim of this study was to compare indigestible internal markers (naturally occurring odd-chain *n*-alkanes) and total collection techniques for the apparent digestibility estimation in horses by performing some “*in vivo*” digestibility trials that differed according to the forage/concentrate ratios and to the composition of the hays and concentrates.

2. Materials and methods

The fecal recovery of alkanes was determined in two digestibility trials at the Experimental Horse Stud of the Italian Agricultural Ministry in the Isernia District (Central Italy). The protocol was approved by the Institutional Animal Care and Use Committee.

The first trial was performed on four saddle horses, aged from 6 to 10 years and weighing 553.5 ± 28.9 kg. The horses were fed on diets with 50:50, 75:25 and 100:0 forage to concentrate ratios, respectively, on a dry matter basis (Diets 1, 2, and 3). The hays were Mediterranean first meadow cuttings, harvested in June 2002.

The ingredients of the commercially mixed feeds (ACME, Reggio Emilia, Italy) are listed hereafter in decreasing order according to weight: citrus pulp, maize, barley, soybean meal, steam flaked wheat, carob pulp, cane molasses, hydrated di-calcium phosphate, premix Ran-Jet ACME[®], live yeast, calcium carbonate, sodium chloride, soybean oil, acidifying agent, premix It-Is ACME[®], premix Ostepron ACME[®], and lactulose.

The second trial was performed on 5 saddle horses, aged from 6 to 10 years and weighing 535.0 ± 39.1 kg. The forage to concentrate ratio was 50:50 and 100:0, respectively, on a dry matter basis (Diets 4 and 5). The hays were Mediterranean first meadow cuttings, extensively used in Italy for horses, harvested in June 2003. The ingredients of the commercially mixed feed (ACME, Reggio Emilia, Italy) are the same as the first trial but with apple pectin pulp instead of citrus pulp.

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