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Digestibility of a forage-based diet in weanling horses during development and maturation

M.T. Saastamoinen*, S. Särkijärvi

Natural Resources Institute Finland, Animal Production Technology, Equines, Opistontie 10 a 1, 32100 Ypäjä, Finland

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ABSTRACT

The efficiency of digestion could be limited in weanling and yearling horses if lower quality forage-rich rations are applied. In this study diet digestibility was examined in young Finnhorses (5 colts, 5 fillies) after weaning at 7 months of age (215 ± 8.0 days) up to the age of twelve months when a high-forage diet with long-stem medium or lower quality hay was fed. The experimental diet consisted of timothy-dominated dry hay (70% of the DM intake), oats (22%) and a protein concentrate. The experimental period consisted of six 4-wk periods, including an acclimation period of 23 d followed by a 5-day period of faeces sample collection. To follow and observe the development of the young horses, they were weighed and body measures were taken at 2-wk intervals. Digestibility data were observed using chromium-mordanted straw as an indigestible external marker. No gradual statistically significant improvement of digestion of nutrients could be detected from 7 to 12 months of age. However, the digestibilities of the nutrients numerically increased from the first (7 months of age) to the sixth period (12 months of age), except the CP digestibility. It appears that weanling and yearling horses can properly digest their forage-based diets. However, the ability to digest fibre may still be limited at the age of 12 months, and attention should be paid to the fibre content and nutritional quality of forage.

1. Introduction

There has been considerable research on growth and development as well as nutrient requirements and diet formulation of growing horses, mainly concerning weanlings and yearlings. Forage intake and grazing time have been observed to increase with age while suckling decreases (Crowell-Davis et al., 1985; Faubladier et al., 2013), demonstrating that solid fibre-rich feeds already rapidly become important source of nutrients in suckling foals. However, compared to mature horses, only little published data exist regarding digestibility of diets or nutrients in weanling horses, or the possible development of digestibility during maturation.

Smyth (1988) concluded that periods of rapid increase in the length and size of various intestinal segments are associated with periods of rapid body growth. One of the most rapid growth periods of young horses of various breeds occurs between 6 and 12 months of age (Ellis and Saastamoinen, 2008). Earing et al. (2013) found that digestibility of dry matter, organic matter and NDF was similar for weanling colts and mature geldings when good-quality cubed forage was fed. However, the efficiency of microbial digestion could be limited in young growing horses if lower quality forage-rich diets are applied. Cymbaluk (1990) reported that mature ponies digested energy and fibre better than 8-month-old horses fed with the same forage-based diet.

The nutritional quality of the forage might be often low. In Finland, for example in the period from 2006 to 2011, only 11% of the haylage and 6% of the hay samples could be classified as high quality, and about one-third of the feed samples were considered as medium quality, in terms of NDF and CP contents (Saastamoinen and Hellämäki, 2012). Higher intakes of forage are beneficial to young horses regarding their gut health and, are therefore recommended for them (Flores et al., 2011; Mack et al., 2014). In addition, there has been no published research in which digestibility has repeatedly and regularly been measured in young horses during their rapid growth after weaning.

The aim of this study was to examine diet digestibility in young horses after weaning up to the age of twelve months when a high-forage diet with long-stem medium or lower quality hay was fed.

2. Material and methods

The digestibility of a forage-based diet was examined in young horses aged between 7 months (215 ± 8.0 days) and 12 months (370 ± 8.0 days). Ten Finnhorse weanling horses (5 fillies, 5 colts; expected mature weight 530–550 kg), owned by MTT Agrifood Research Finland (currently Natural Resources Institute Finland,

* Corresponding author.
E-mail address: markku.saastamoinen@luke.fi (M.T. Saastamoinen).

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Luke), with a good health status and an initial mean body condition score (BCS) of 4.3 (scaling 1–7; scores 3 – 4 considered desirable for weanling and young horses; Luke, 2015), were included in this 24-wk study. The foals were weaned 4 weeks before beginning of the experiment.

All experimental horses had the same managing and feeding history: Approximately 2–4 weeks after birth, they were turned to a good-quality pasture (Luke, 2015) with their dams, where they started to ingest meadow grass. Only a mineral supplementation was fed during pasturing. After the grazing season, when the foals were about 4 months old, they were moved indoors and stabled with their dams. They were offered timothy-dominated dry hay from the same parcels that were used in the experimental periods, for about two months before weaning. After weaning, the foals were stabled in individual stalls (bedded with peat) and fed individually such that the dry matter (DM) and nutrient intakes were aimed to be adjusted for moderate growth according to the Finnish feeding recommendations (Luke, 2015).

The experimental diet consisted of timothy-dominated dry hay (70% of the DM intake), oats (22%) and a protein concentrate (8%; Suomen Rehu Ltd, Seinäjoki, Finland), to ensure sufficient diet protein quality. The hay and oats were produced by MTT in South-West Finland (latitude 60°). The diet was supplemented with a vitamin-mineral mixture to balance the intakes, and divided into three meals. The average chemical composition and feed values of the experimental feeds are presented in Table 1. The hay was representing “lower” medium-quality Finnish hay (Luke, 2015). However, although the hay parcels were selected and monitored before the experiment, there was some variation in the quality of the hay, especially during the periods 2 and 5, when the CP content of the hay was higher (102.4 and 104.6 g/kg DM, respectively) than the average content of all experimental hays presented in Table 1.

To follow and observe the development of the foals, they were weighed and body measures (heart girth circumference, height at withers, height at croup, cannon bone circumference) were taken at 2-wk intervals. The body condition score (BCS) was assessed at the same intervals in order to adjust the feeding level (Kienzle and Schramme, 2004; Mack et al., 2014). The experimental design was a completely randomized design with repeated measures. The experimental period consisted of six 4-wk periods, each comprising an acclimation period of 23 d followed by a 5-day period of faeces sample collection (spot samples twice a day). Daily samples were stored at −24 °C until mixed, sub-sampled and dried for laboratory analysis. Feed samples were collected and stored in the same manner as the faecal samples. Any daily feed refusals, from the previous 24 h, were collected and weighed. Feed and faeces samples were analyzed (MTT Laboratories, Jokioinen, Finland) for dry matter (DM), organic matter (OA), crude protein (CP), crude fibre (CF), ether extract (EE), neutral detergent fibre (NDF) and ash content using standard methods (e.g. Särkijärvi and Saastamoinen, 2006). The nitrogen free extract (NFE) was calculated (100-CP-CF-EE-ash). Lysine contents of hay and oats were applied from the Finnish Feed Tables (Luke, 2015) and, that from the protein supplement from the manufacturer's analysis. Digestibility data were observed by using chromium-mordanted straw (68 mg Cr/d DM) with a daily dose of 1.6 mg/kg feed DM as an indigestible external marker for the estimation of apparent digestibility. Chromium-mordanted straw was prepared according to Udén et al. (1980).

Table 1
Average composition (with ranges) of the experimental feeds.

Feed	Hay	Oats	Protein supplement
DM (g/kg)	884.3	876.6	881.2
	868.6–909.8	861-2-880.2	876.8–883.6
OM (g/kg DM)	942.0	971.0	900.0
	925.3–948.2	970.6–972.7	899.6–900.5
CP (g/kg DM)	94.9	108.0	288.2
	87.9–104.6	105.1–111.1	282.0–290.8
EE (g/kg DM)	18.1	57.6	66.4
	14.9–20.2	55.7–63.1	65.8–67.0
NDF (g/kg DM)	672.6	261.8	178.6
	648.0–681.0	243.0–289.3	172.4–185.4
CF (g/ kg DM)	341.7	98.4	103.0
	326.6–357.6	86.4–117.2	101.4–105.4
NFE (g/kg DM)	487.3	707.1	442.5
	461.3–502.1	683.9–720.9	439.0–448.4
Ash (g/kg DM)	58.1	29.0	100.0
	51.8–74.7	27.3–32.3	99.5–100.4

The data were statistically analyzed at the following mixed model (MIXED procedure of the SAS system, SAS, 1998): $Y_{ijk} = \mu_{ijk} + a_i + p_j + s_k + (p \times s)_{ijk} + e_{ijk}$, where μ_{ijk} is the overall mean, a_i is the random effect of the animal (i = 1,…10), p_j is the fixed effect of the period (j = 1,…6), s_k is the fixed effect of the sex, $(p \times s)_{ijk}$ is period-sex interaction, and e_{ijk} is the normally distributed error with a mean of 0 and variance δ^2. The differences were tested with Tukey's test.

In animal handling and sample collection, the EC Council Decision 1999/575/EC and national animal welfare and ethical legislation set by the Ministry of Agriculture and Forestry in Finland were carefully followed. The experimental procedures were evaluated and approved by the Animal Care Committee of MTT before the study started.

3. Results

Daily intakes of energy, dry matter, digestible crude protein and approximated lysine, as well as dry matter intakes as percentages of the body weight, are presented in Table 2. The DM as well as the energy and lysine intakes increased as the foals matured and increased their body size. The average intake of DM during the study period was 2.07% of the body weight, being greatest during the period 2 in the 8-month-olds (Table 2).

Of the body measures, body weight, height at withers and heart girth circumference are presented in Fig. 1. The weight and body measures increased as the horses matured. The initial body weight was 279 ± 9.1 kg and the final weight was 356 ± 16.5 kg. The average daily gains (ADG) were 516, 650, 333, 417, 500 and 422 g/d for the 4-wk periods 1–6, and 497 g/d for the whole experimental period. The BCS of the foals decreased soon after the beginning of the trial from the mean of 4.3 to 3.5 (scale 1–7) and was maintained at this level during the study period.

No statistically significant gradual changes were observed in the diet nutrient digestibilities during the course of the trial (Table 3). However, the digestibilities of the nutrients numerically increased from the first (7 months of age) to the sixth period (12 months of age), except for the CP digestibility, for which the variation between the periods was smaller than that of the other nutrients. The digestibilities in the second period were higher than in the other periods ($P < 0.001$). The digestibility of fibre (NDF, CF) was low, also displaying quite a large variation between the time periods. However, both the digestibilities of NDF and CF showed improved values towards the last period, i.e. at the age of 12 months. The digestibilities did not statistically significantly differ between fillies and colts.

4. Discussion

The dry matter and nutrient intakes increased during the study period due to the increased intake capacity and because of adjusting the intake for moderate growth and maintaining the BCS, which has been reported to be a good tool to assess the energy level of growing horses (Kienzle and Schramme, 2004; Mack et al., 2014). The intakes of digestible CP and lysine fluctuated because of the changes in the CP content of the hay parcels used in different 4-wk experimental periods; during the periods 2 and 5, the CP content of the hay was higher than the mean CP content of all hay parcels used in the experiment. Maintaining the appropriate forage-to-grain ratio (F:G 70:30) and the