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Short communication

The effect of feeding a low- or high-starch diet on equine faecal parameters

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ABSTRACT

Seven mature Welsh-cross pony geldings provided the faecal inocula in a cross-over design experiment, consisting of two 14-day periods. In period 1, four ponies (group 1) were fed a low-starch fibre-mix (LS), and three (group 2) were fed a conventional high-starch coarse-mix (HS), both groups were fed these mixes in a 50:50 ratio with mature grass hay, to give a total daily dry matter (DM) intake of 17.5 g/kg live weight per day. Diets were then switched in period 2. At the end of each experimental period freshly voided faeces were collected from each animal and analysed for cellulolytic and amylolytic bacterial numbers, volatile fatty acid (VFA) and lactate concentration. There was no effect of diet on the number of cellulolytic and amylolytic bacteria, VFA or lactate present in the faeces of the experimental ponies. Consequently, it would appear that the effect of feeding LS or HS on faecal parameters is minimal; however, further work is required to determine the accuracy of faeces as a model for changes in the hindgut environment of the horse.

1. Introduction

Horses have evolved to survive on a diet consisting of large quantities of low-quality fibre, ingested on an almost continual basis. However, the nutrient, and in particular energy demands of performance horses have necessitated the incorporation of large amounts of energy-dense cereal grains in the diets of these animals, which are high in starch and low in fibre. It is well known that the small intestine of the horse has a limited capacity for starch digestion (Kienzle et al., 1994; Meyer et al., 1995) and thus when high levels of starch are fed in a single meal, undigested starch enters the hindgut. Excess starch entering the hind-gut favours the proliferation of Gram positive lactic acid producing bacteria in the hindgut of the horse at the expense of the Gram negative fibre-degrading bacterial population. The increase in lactate, volatile fatty and acids (VFA) and consequent reduction in gut pH elicited through feeding high-starch diets can cause a number of intestinal and metabolic disorders in horses such as colic and laminitis (Rowe et al., 1994). Therefore, the present study was undertaken to examine the effects of feeding a low- or high-starch diet on faecal parameters.

2. Materials and methods

2.1. Experimental design

Seven mature Welsh-cross pony geldings (280 kg ± 17.6 LW) provided the faecal inocula in a cross-over design experiment whereby four ponies (group 1) were fed a low-starch fibre-mix (LS) containing 186 g/kg DM of starch, and

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three (group 2) were fed a conventional high-starch coarse-mix (HS) containing 512 g/kg DM of starch. Both mixes were proprietary mixes and there was no information on how the ingredients were processed. Both mixes were fed in a 50:50 ratio with mature grass hay (Hay), to give a total daily dry matter (DM) intake of 17.5 g/kg LW per day. Each diet was fed in two equal meals, giving a starch intake per meal of 1.2 and 2.2 g/kg LW for LS and HS, respectively. Each diet was fed for a period of 14 days, after which group 1 was offered diet HS and group 2 was offered diet LS. At the end of each 14-day period freshly voided faeces were collected immediately after defecation from each animal and analysed for cellulolytic and amylolytic bacterial numbers, VFA and lactate concentration.

2.2. Chemical analyses of feedstuffs

Feed samples were analysed for DM, neutral detergent fibre (NDFom), acid detergent fibre (ADFom), starch, water soluble carbohydrate (WSC), gross energy (GE) sodium (Na), calcium (Ca), phosphorus (P), potassium (K) and magnesium (Mg) according to the methods described by (Murray et al., 2008).

2.3. Faecal most probable number (MPN) counts

At the end of each of the 14-day period, freshly voided faeces were collected before the morning feed (09:00 h) from each pony and placed separately in pre-warmed (39 °C) flasks for transportation to the laboratory. Faeces were tightly packed in the collection vessels to maintain anaerobic conditions. Each faecal sample was processed separately for MPN counts according to the technique described by Davies et al. (1993). Cellulolytic and amylolytic anaerobic bacteria were enumerated by MPN procedures using grass hay (ground through a 1 mm dry mesh screen) and soluble starch (BDH, Poole, Dorset) as substrates, respectively. The chemical composition of the feedstuffs is given in Table 1.

Enumerations were performed on 10 g (fresh weight) quantities of fresh faecal samples. Faecal samples (10 g) were combined with 90 ml of anaerobic culture medium as described by Davies (1993) and homogenised in a stomacher (Laboratory blender stomacher 400, Seward, London, UK) for 2 min. This resultant suspension 10 ml of was sub-sampled and serially diluted in 90 ml of culture medium. Positive and negative tubes were employed for MPN enumerations using three replicates per dilution and 10^{-7}–0^{-13} dilutions.

Growth of cellulolytic and amylolytic bacteria was estimated by increased turbidity after seven days incubation at 39 °C. MPN counts were expressed on a faecal DM basis. The data were transformed to $\log_{10}$ since the logarithmic distribution tends to be more symmetrical in comparison to that of the estimated density values (Cochran, 1950).

Table 1
Chemical composition of the dietary ingredients; grass hay (Hay), fibre-mix (FMix), starch-mix (SMix) and the two experimental diets consisting of Hay fed in a 50:50 ratio with either fibre-mix (LS) or starch-mix (HS) (g/kg DM unless otherwise stated).

	Hay	FMix	SMix	Diets	
				LS	HS
DM (g/kg)	912	900	885	906	898
OM	848	821	823	834	835
CP	62	123	122	92	92
Starch	36	186	512	111	274
WSC	186	94	58	140	122
ADF	356	197	83	277	220
NDF	615	351	196	483	405
GE (MJ/kg)	18.3	19.2	18.1	18.7	18.2
Sodium	1.3	3.1	0.6	2.2	0.9
Potassium	6.8	8.3	5.5	7.5	6.1
Calcium	4.1	12.3	12.1	8.2	8.1
Phosphorus	1.3	3.7	3.0	2.5	2.2
Magnesium	1.6	3.6	1.7	2.6	1.6

2.4. Faecal VFA and lactate analyses

VFA and lactate contents were determined on water extracts of freshly voided faeces. Extracts were prepared by placing a 20 g fresh matter sample of faeces in 100 ml of distilled water. Samples were then shaken and filtered through a sieve (1 mm pore size). The resultant filtrate was then acidified with 0.5 ml H_3PO_4 and stored at 4 °C for 24 h prior to freezing at −20 °C. Samples were then defrosted and analysed for VFA and lactate content according to the method of Merry et al. (1995).

2.5. Statistical analyses

Values for the most probable number counts, and VFA and lactate concentrations were analysed for significant differences as a cross-over design using restricted maximum likelihood (REML) in Genstat 5 Lawes Agricultural (Trust, 1993). Comparisons between treatment groups were made by least significant difference equations.

3. Results

Starch levels were lower for the hay in comparison to the FMix and SMix; the SMix contained almost three fold the amount of starch (512 g/kg DM) compared to the FMix (186 g/kg DM; Table 1). Consequently, the starch content of the HS diet (274 g/kg DM) was 2.5 times higher than that of the LS diet, which contained 111 g/kg DM. In terms of starch intake, ponies that were fed the HS diet received 2.2 g starch/kg LW, whilst those fed with the LS diet were offered 1.2 g/kg LW. ADFom and NDFom contents were the greatest in the hay, the lowest in the SMix and intermediate in the FMix (Table 1).

There were no horse–diet interactions for microbial counts, VFA or lactate concentrations. There was no effect of diet on the number of cellulolytic and amylolytic bacteria present in the faeces of the experimental ponies (Table 2). Moreover, there was little inter-animal variation in the number of cellulolytic and amylolytic bacteria present in the faeces (Table 3). Faecal VFA concentration was also similar across both diets (Table 2); however, there was an inter-animal variation in total VFA concentration, attributable to differences in the concentration of acetate and butyrate present in the faeces of these animals (Table 3). Faecal lactate concentration was similar across both diets and for all ponies