

Feed Form Affects Growth and Stomach Ulcers in Yearling Horses

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Abstract: Fourteen yearling standardbred horses were used to test the hypothesis that hay and grain fed as a complete total mixed ration (TMR) cube diet (C) would result in greater average daily gain (ADG), feed efficiency (gain to feed ratio, G/F) and apparent digestibility in horses on the TMR diet compared to horses fed the same weight and proportion of hay cubes and grain fed separately (diet HG). Both diets consisted of 75% forage and 25% ground oats. The forage in both the plain hay cubes and the complete cubes was 80% alfalfa and 20% endophyte-free tall fescue. An additional hypothesis that stomach ulceration would not differ between horses fed either of the two diet treatments was also tested by comparing upper gastric endoscopies before and after 70 days of feeding the experimental diets. Horses fed diet C had greater ADG ($P < 0.046$) while G/F between the two treatments was not significantly different ($P > 0.065$) but showed a trend to be higher in the horses consuming diet C. Apparent digestibility of dry matter and crude protein was not different between the diet treatments, and no major gastric ulceration was found in horses consuming either diet treatment. The results of this study found that a complete cubed diet of 75% hay and 25% oats did not cause stomach ulceration while achieving an acceptable growth rate in yearling horses.

Key words: Horse, growth, digestibility, total mixed ration, stomach ulcer.

1. Introduction

When selling yearlings at auction, larger horses (heavier weights and taller wither heights) are generally more profitable [1]. Achieving rapid growth, however, may also be associated with metabolic disorders [2]. Osteochondrosis, epiphysitis, angular limb deformities and stomach ulcers have all been associated with high starch diets used to achieve rapid growth [3-5] and abnormal cartilage growth has been linked to insulin levels [6, 7]. To attain maximum weight growth in young horses and maximize profit at auction, starch and sugar intake should be evenly distributed throughout the day without feeding large amounts of these carbohydrates at one time. One method of achieving this goal is to provide feed as a

total mixed ration (TMR). A previous study found that a diet of 50% grain and 50% hay cubes that was ground and formed into complete pellets improved weight gain over an identically composed diet of 50% grain and 50% hay cubes fed separately [5]. However, horses on both treatment diets had significant stomach ulceration, and the complete pelleted diet did not reduce gastric ulceration. The current study tests the hypothesis that yearling horses fed a complete cube diet (C), consisting of 75% hay and 25% ground oats fed together as a complete cube, will have higher average daily gain (ADG), dry matter and crude protein digestibility, and gain to feed ratio (G/F) than yearlings fed a diet of 75% hay cubes and 25% ground oats fed separately (HG). We further hypothesized that neither treatment diet would cause significant gastric ulceration in the horses due to the lower grain inclusion rate as compared to a previous study [5].

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2. Materials and Methods

Fourteen yearling standardbreds, seven fillies and seven colts, with an average age of eight months, and an average initial weight of 294 kg, were used to compare differences in ADG and G/F when fed a complete diet C, or an identically formulated diet in which the hay cubes and oats were not further processed into complete cubes (HG), and were fed in separate containers (Table 1). Both diets consisted of 75% forage and 25% ground oats. The forage in both the plain hay cubes and the complete cubes was 80% alfalfa and 20% endophyte-free tall fescue. All feedstuffs except supplemental salt and mineral blocks were provided by Next Generation Feeds[®], Cokato, MN. All horses additionally had free-choice access to salt and mineral blocks (MoorMan's[®] GROSTRONG[®] minerals, regular formulation). Diets were fed for 75 days, during which time horses were fed no additional feeds of any kind, and had constant access to water. Horses were weighed on an electronic platform scale before the start of the study, and weekly for the study's duration. Upper gastrointestinal tract endoscopies were performed on all horses at the beginning and end of the study, and gastric ulcers were scored according to the number/severity scoring system for grading EGUS lesions [8] (Table 2).

Seven horses were assigned to each diet and fed

twice daily at 7:00 a.m. and 19:00 p.m. at a rate of 1.5% body weight at each feeding. Horses were housed and fed in individual pens with identical feeders. At each feeding, leftover feed from the feeders was recovered and weighed to determine feed consumption. Samples of the feed were collected throughout the study and composited. Fecal samples were collected for five consecutive days after 70 days of the study. Feces were composited, frozen and stored at -4 °C. Once all collections were complete they were dried in an oven at 60 °C. Feed and fecal samples were sent to a laboratory (Equi-Analytical Labs, Ithaca, NY) for analysis of dry matter, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and acid insoluble ash (AIA) using AOAC methods [9]. Apparent digestibility was calculated using Eq. (1):

$$100 \times (1 - \text{AIA in feed (\%)/AIA in feces (\%)}) = (\text{nutrient in feces (\%)/nutrient in feed (\%)}) \quad (1)$$

Differences in apparent digestibility and in ADG and G/F of horses between diet treatments were determined using *t*-test. The Institutional Animal Care Advisory Committee, University of Illinois, Urbana-Champaign, approved all animal care procedures.

3. Results

Table 3 shows the raw data for percent fecal CP,

Table 1 Analysis of diets and dry matter basis.

Analysis	Complete cubes (%)	Hay cubes (%)	Grain (%)
Crude protein	16.7	16.0	18.9
ADF	34.8	40.7	17.2
NDF	48.7	54.9	30.1
Acid insoluble ash	4.15	5.3	0.7

Table 2 Number/severity scoring system for grading EGUS lesion [9].

Grade	Number of lesions	Severity
0	None	Normal
1	1-2 localized lesions	Appears superficial
2	3-5 localized lesions	Deeper structures involved
3	6-10 lesions	Multiple lesions and variable severity
4	> 10 lesions	Same as grade 2 but with an active appearance
5	N/A	Same as grade 4 though with active hemorrhage or clot adherent

Table 3 Fecal CP, AIA and apparent CP and DM digestibility for diet treatments C and HG.

Horse	Treatment	CP (%)	AIA (%)	Dry matter digestibility (%)	Crude protein digestibility (%)
1C	C	10.90	6.3	65.9	57.1
2C	C	10.70	6.5	63.8	59.2
3C	C	11.00	5.5	75.5	50.4
4C	C	11.00	6.8	61.0	59.9
5C	C	10.00	6.7	61.9	63.0
6C	C	10.40	6.2	66.9	58.4
7C	C	12.50	7.8	53.2	60.2
Mean ± S.E.		10.9 ± 0.30a	6.5 ± 0.26a	64.0 ± 2.6a	58.3 ± 1.5a
1HG	HG	9.4	5.4	76.8	56.8
2HG	HG	10.6	7.0	59.3	62.4
4HG	HG	10.9	6.2	66.9	56.4
5HG	HG	11.2	6.2	66.9	55.2
6HG	HG	10.8	6.5	63.8	58.8
7HG	HG	10.6	6.2	66.9	57.6
Mean ± S.E.		10.6 ± 0.25a	6.3 ± 0.21a	66.8 ± 2.3a	57.9 ± 1.0a

Values with same letter between treatments are not significantly different ($P > 0.05$).

Table 4 ADFI, ADG and G/F of horses in each diet treatment.

Horse	Treatment	ADFI (%)	ADG (%)	G/F (%)
1C	C	18.79	1.10	0.058
2C	C	21.34	1.69	0.079
3C	C	19.58	2.99	0.153
4C	C	18.70	1.21	0.065
5C	C	23.47	1.41	0.060
6C	C	17.71	0.90	0.053
7C	C	17.82	2.60	0.145
Mean ± S.E.		19.63 ± 0.79a	1.69 ± 0.30a	0.09 ± 0.016a
1HG	HG	17.29	1.10	0.063
2HG	HG	17.69	1.09	0.058
4HG	HG	18.81	1.10	0.061
5HG	HG	17.20	0.70	0.043
6HG	HG	20.11	0.70	0.034
7HG	HG	21.10	1.10	0.050
Mean ± S.E.		18.70 ± 0.66a	0.96 ± 0.08b	0.05 ± 0.005a

Values with different letters between treatments are significantly different ($P < 0.05$).

AIA and calculated values for apparent CP and DM digestibility on horses in both diet treatments, on a dry matter basis. One horse fed HG diet had a fecal AIA value only 73% of the mean of the remaining horses in the HG treatment, and was considered an outlier, and excluded from the data analysis for diet HG. There were no significant differences ($P > 0.05$) between the two treatments in apparent dry matter digestibility or apparent CP digestibility. Diet C had an apparent dry matter digestibility of 64.0 ± 2.6 while

diet HG's was 66.8 ± 2.3 . Diet C had an apparent CP digestibility of 58.3 ± 1.5 while diet HG's was 57.9 ± 1.0 . Table 4 shows the raw data for estimated average daily feed intake (ADFI) for horses on each diet treatment calculated as feed provided minus recovered feed refusals, the ADG and G/F for horses on each diet treatment. Horses fed diet C had an ADG (kg/day) ± SEM of 1.69 ± 0.30 while horses fed diet HG had an ADG of 0.96 ± 0.08 . Horses fed diet C had a feed efficiency (G/F ± SEM) of 0.09 ± 0.016 while horses

fed diet HG had a feed efficiency of 0.05 ± 0.005 . ADG was found to be significantly different ($P < 0.05$) between the two diet treatments while G/F between the two treatments was not significantly different ($P > 0.05$) but showed a trend to be higher in the horses consuming diet C. The ADFI was not statistically different ($P > 0.05$) between diet treatments but was numerically slightly greater for horses consuming diet C. The endoscopies performed on all horses before the start of the study found only one horse with a single mild ulcer of grade one (Table 2). Upon completion of the study, endoscopies found that none of the horses had any detectable ulcers.

4. Discussion

The results of this study support the hypothesis that yearling horses fed a complete cubed diet of 75% hay and 25% oats would have higher ADG than yearling horses fed a diet of 75% alfalfa hay cubes and 25% oats fed separately. However, the G/F and apparent digestibility of DM and CP between diets were not found to be different. A previous similar study in our lab found that the growth of weanling horses fed forage and concentrates mixed together as a completely pelleted diet exceeded that of horses provided the same forage and concentrate fed separately as hay cubes and texturized grain [10]. Yet another study from our lab found that feeding a completely pelleted diet using either corn and soybean meal, or partially replacing corn and soybean meal with distillers dried grains with solubles as the concentrate along with ground forage, resulted in good growth rates and no observable ill effects in weanling horses [11]. A significant difference in G/F in the current study may have been detected had a greater number of horses been used. The difference in ADG may be due to more consistent grain/hay intake in diet C versus alternating grain and hay intake in diet HG. The alternating hay and grain consumption in diet HG might have caused fluctuations in gastrointestinal tract pH and/or microbial populations. It is also quite possible that small particle size contributed to

undetected grain loss in diet HG and thus it was not included in feed waste. The manufacturer of the complete cubes used in this study thought that grinding of the oats before inclusion in the complete cube might improve digestibility of the oats, although previous research regarding processing of oats has found otherwise [12]. In order to separately feed the same ingredients included in the complete cube, ground oats were fed in the HG diet which may have led to greater unmeasured loss of some of the starch in the HG diet since it was not bound to forage by the cubing process and was more likely to be lost as fine starch particles. The finding in this study that neither diet treatment caused any notable stomach ulceration differed from a previous study in our lab that found numerous stomach ulcers in weanlings consuming completely pelleted diets when 50% of the completely pelleted diet was comprised of grains and other concentrates [5]. The results support the additional hypothesis that neither diet would cause significant gastric ulceration.

5. Conclusions

It is concluded that a complete cubed diet of 75% alfalfa hay (80% alfalfa hay, 20% tall fescue) and 25% ground oats does not cause stomach ulceration while achieving an acceptable growth rate in yearling horses. It is possible that the greater ADG of horses fed the completely cubed diet (diet C) was due to more consistent intake of forage and grain while consuming this product, but it also may have been due to immeasurable loss of starch from the ground oats fed separately to horses on the HG diet.

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