Will total mixed rations be the future of horse feeding?

Sarah L. Ralston[1] and Harlan Anderson[2]
[1]Rutgers, the State University of New Jersey, Dept. Animal Science, 84 Lipman Drive, New Brunswick, NJ 08901, USA; Ralston@aesop.rutgers.edu
[2]IdleAcres, 2379 Quimby Ave SW, 55321 Cokato, MN, USA

Introduction

Forage-based total mixed rations (TMR), wherein all the nutritional needs of the animals are met in a single feedstuff, have been used successfully for decades in growing and adult food animals. The advantages to use of TMRs over traditional long stem hay/concentrate rations is the ease of handling, reduced waste, ability to completely control/regulate nutrient intake and, in some regions cost and improved nutrient availability. In addition, in our increasingly non-agricultural societies, horse owners frequently have little knowledge of judging hay quality and adjusting feed intakes of concentrates to accommodate variations in hay nutrient content. The result is frequently over- or underfeeding nutrients. Over feeding nutrients such as nitrogen (protein) and phosphorus are increasingly becoming environmental concerns (Williams *et al.*, 2011; Westendorf *et al.*, 2011). The use of TMRs would allow specific formulation that could meet but not exceed recommended intakes.

The majority of the available 'complete' feeds are usually provided in a pelleted form and are sufficiently dense calorically that they must be offered in very restricted (< 1.5% BW) amounts to avoid obesity. Pelleted complete feeds have also been documented to be associated with a high incidence of gastric ulceration (Flores *et al.*, 2009). Horses can usually consume their total daily allotment of 'complete' pellets in less than 5 or 6 hours, whereas horses allowed free access to feed spend 10 to 12 hours engaged in eating activity. Grain-based concentrates fed in distinct meals, with or without concurrent hay access, result in significant increases in plasma glucose and insulin (Ralston, 1996; Trieber *et al.*, 2005), and may increase the incidence of developmental orthopedic disease (DOD) such as osteochondrosis

(OCD) in predisposed young horses (Ralston, 1996; Pagan *et al.*, 2001), though the association between non structured carbohydrates (NSC) intake and OCD is not 100% (Ralston *et al.*, 2007, 2011). High grain/starch/sugar intakes are also commonly associated with the development of insulin resistance in adult horses (Frank *et al.*, 2010) and aggravation of rhabdomyolysis in horses with polysaccharide storage myopathy (Valberg, 2011).

TMR formulated with grain added

In a series of experiments conducted over the past 7 years we have documented the safety and efficacy of TMRs with or without added grains for use in young horses. In the three initial trials (2004-2006), in October of each year 12 draft cross weanlings were paired by sex and type and fed either TMR cubes (Next Generation™, IdleAcres, Cokato, MN) free choice (TMR, n = 6 per year)) or Nutrena® (Minnetonka, MN) Life Design Youth® (HCY:2004, 2005) or SafeChoice® (HCSC, 2006) to provide 50% of the calories recommended for growth (NRC, 1989) with ad libitum grass/alfalfa mix hay (n = 6 per year) for 6 to 8 weeks. Feed intakes were recorded daily and height and weight were measured weekly. The horses were evaluated visually for the presence of developmental orthopedic disease before and after each trial by an experienced observer blind to the dietary treatments. The studies were repeated for 6-8 weeks each spring in a crossover design. The horses were given a low dose oral dextrose challenge test (0.25 gm dextrose/kg BW, Ralston, 2002) before treatments were initiated and after 6 to 8 weeks on their respective treatments and plasma glucose/insulin responses to consuming equicaloric amounts of the TMR versus concentrate used were also measured. Nutrient content of the rations differed somewhat between years (Table 1). In the first two trials the TMR cubes had 10-15% cracked corn added to the formulation, in the third ground oats were used instead of corn.

Feed efficiency (kg gain/Mcal DE consumed) was higher ($P < 0.05$) in the TMR horses relative to the traditional hay/concentrate horses in all three years and all trials. Growth rates tended ($P < 0.1$) to be slightly higher in the TMR horses and were definitely higher (average of 1.2 kg/day in the draft cross weanlings, 0.8 kg/day in the yearlings) than predicted by NRC (1989) in all three years. The horses voluntarily consumed between 2.5 and 3.0% of their body weight

Table 1. Nutrient content of rations used 2004-2006. Values are on DM basis of feed.

Year/feed	2004 HGY[1]	2004 TMR	2005 HGY[1]	2005 TMR	2006 HGSC[1]	2006 TMR
DE Mcal/kg	2.4	2.2	2.2	2.2	2.6	2.4
% Protein	14.0	18.2	11.0	16.7	14.7	15.6
% NSC	20.0	16.5	20.0	13.0	15.4	15.0
% Ca	0.88	1.47	0.73	1.07	1.0	1.18
% Phos	0.45	0.42	0.35	0.32	0.54	0.32

[1] Based on mean total hay/concentrate consumed per day. Grass/alfalfa mix hay quality in 2004, 2006 was good, 2005 hay was only moderate.

daily as weanlings, in the spring trials voluntary feed intakes tended to decrease to 2.2 to 2.5% BW. In 2005 two weanlings had DOD (flexure deformities and epiphysitis) and were hyperinsulinemic before the treatments were initiated, one was placed on TMR, the other on HGY. The one on TMR resolved, the one on HGY continued to have severe epiphysitis and flexure deformities throughout the study and in the subsequent spring when placed on TMR. In 2006 two horses had DOD (flexure deformities and epiphysitis) that did not resolve on either ration. Plasma glucose responses to the dextrose challenges did not differ between treatments in the first two years but insulin responses tended ($P < 0.1$) to be higher in HGY fed horses, suggesting somewhat reduced insulin sensitivity. In 2006 there were higher ($P < 0.05$) glucose and insulin responses on TMR than HGSC but that was the year the TMR had 10% ground oats added instead of corn and the SafeChoice® pellets had been specifically formulated to have a low glycemic index. Post-prandial glucose and insulin responses to the meal of SafeChoice® were low compared to HCY and the TMR for the first 90 to 120 minutes but then tended to increase and stay higher ($P < 0.05$) than the other treatments for the next 60 to 90 minutes of samples collection (Ralston *et al.*, 2007). The only feed-related adverse event was a recurrent choke in one horse that was fed the pelleted ration which was prevented when the concentrate was soaked in water prior to feeding. The horses were not, however, evaluated for gastric ulceration, though there was no clinical evidence (poor appetite, colic, etc) of ulceration in any of the horses.

The results obtained with the draft crosses were corroborated in a study at another university, using Standardbred yearlings fed either TMR cubes with 25% oats at the rate of 3% BW/day versus equivalent amounts of hay cubes and oats fed separately as discrete meals. The same hay was used in both types of cubes. The horses on the TMR rations again had higher ($P < 0.05$) growth rates (1.69 kg gain/d) and gain to feed ratio (0.9 kg/kg feed intake) than the meal fed animals (0.95 kg gain/day, 0.05 kg gain/kg feed). No gastric ulcerations were found on endoscopic examination in either treatment group (Warren *et al.*, 2011).

TMR formulated without grain

In more recent studies (Ralston *et al.*, 2009) it was hypothesized that grain free forage-based TMR rations could be formulated to meet or exceed all nutrient recommendations for rapid growth when fed free choice and that young horses fed the TMR ration would have comparable or better growth rates and feed efficiency compared to those fed traditional long stem hay/ grain rations. Twelve draft cross weanlings (6 colts and 6 fillies, initially 5 months old) were fed either TMR cubes (Next Generation©, IdleAcres, Cokato, MN) free choice (TMR, n = 6) or hay/concentrate based Nutrena® (Minnetonka, MN) Safe Choice® (SCH, n = 6) to provide 50% of the calories recommended for moderate growth with free choice grass/alfalfa hay (see Table 2 for analyses). This time the TMR ration contained no added grain. Wheat bran (< 5%) was added to increase phosphorus content to recommended concentrations and a trace mineral/vitamins supplement was also included to ensure intakes that met or exceeded the recommendations for growth. All weanlings maintained good general health. No significant DOD was observed in either treatment group. Though the SCH horses started out 2 cm taller than the TMR group (SCH: 137 ± 1.2 cm, TMR: 135 ± 1.3, $P > 0.05$) and 14 kg heavier (SHC: 293 ± 7 kg, TMR: 279 ± 8 kg), there were no differences ($P > 0.1$) between treatment groups with respect to average daily gain, weekly height increase, or feed efficiency despite lower ($P < 0.05$) daily feed intakes by the TMR horses (Table 3). The TMR fed horses actually consumed only 85.5% of the calories recommended for growth relative to the 100% intake of the SCH horses.

Table 2. Grain-free TMR nutrient concentrations versus traditional Hay/concentrate ration[1]. Values are concentration % As Fed based on measured intakes of Hay/Concentrate and TMR cubes.

Nutrient concentrations	SCH	TMR
DE Mcal	2.83	1.97
% Protein	16.9	14.3
%ADF	23.8	24.7
%NSC	13.6	6.4
%Ca	1.3	1.4
%Phos	0.57	0.41
%Mg	0.42	0.26

[1] Weanlings consumed an average of 3.0 kg SCH divided into two feedings and 4.8 kg hay per day versus 6.45 kg TMR cubes.

Table 3. Growth and feed intakes of draft cross weanlings (n=6 per group) fed either SCH (100% of NRC for 0.8 kg/day gain) (SCH) versus ad libitum alfalfa based TMR cubes without added concentrates. Values are means ± SE.

	SCH	TMR
%BW intake	2.75±0.06	2.53±0.06
ADG, Kg/day	0.77±0.16	0.85±0.12
Kg gain /Mcal DE	0.04±0.007	0.05±0.007
%NRC[1]	99.8±2.6	85.6±2.7

[1] Percentage of NRC (2007) recommended caloric intake.

In 2009-2010 further trials were conducted using grain-free TMR rations. In 2009-2010 growth rates of 4 yearling mustangs were compared to yearling and weanling draft crosses. The grain-free forage based cubes formula was again used and the TMR was fed free choice. The growth results for the draft crosses were identical to previous years, with the horses voluntarily consuming ~85% of the predicted necessary caloric intake yet sustaining higher growth rates than predicted by NRC (2007) for horses maturing at 650-750 kg. The mustangs consumed 100% of the recommended caloric intake for horses maturing at 450 kg and had the predicted rates of growth.

Again, the horses maintained excellent body condition and there were no adverse effects (i.e. colic, diarrhea, woodchewing, etc.).

The daily cost, based on the commercial price (2009) of the respective feeds (hay: $ 0.41/kg; grain: 0.70/kg, TMR: $ 0.66/kg), was calculated based on actual intakes. It cost an average of $ 4.26/day for the TMR ration versus $ 4.18/day for the SCH. The SCH horses also wasted 0.8 to 1 kg of hay per day, incurring an average loss of about $ 0.30/day in wasted hay that should be added to the daily cost. There was no waste with the cubes. The cost differential between the two rations is further reduced if labor costs are taken into consideration. It was the subjective observation that it took less time to feed the cubes than the hay/grain rations and the bags of cubes were easier to store and handle than the long stem hay bales.

Conclusions

Feeding TMR cubes formulated for growth with or without added grain concentrate free choice is an efficient, economic alternative to traditional hay/high NSC concentrate rations under the conditions of these trials. This type of ration may be especially appropriate for young horses that are predisposed to DOD. Anecdotal reports of use of TMR rations formulated for adult horses have been equally encouraging. With soaring prices for hay and, increasingly, grain in many regions of the world, the use of bagged TMR rations that can easily be transported and stored worldwide may be the most economic and practical answer for horse owners.

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