



Original Research

Relationships Among Digestible Energy Intake, Body Weight, and Body Condition in Mature Idle Horses



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ABSTRACT

The objective of this study was to evaluate the relationships among digestible energy (DE) intake, body weight (BW), and body condition score (BCS) in lean/moderate condition horses. The feed intake of 35 Quarter Horses (age 5.3 ± 1.2 years; BW 462 ± 39 kg; BCS 4.5 ± 0.5) was recorded daily over three, 42-day feeding trials. Horses were offered 1.75–2.00 kg DM/100 kg BW in Orchard grass hay and 0.2 kg/100 kg BW in whole oats. Body weight and BCS were recorded biweekly. Daily DE intake was calculated according to Pagan and recorded as the amount fed minus any refusal. The daily kilogram intake was multiplied by the DE (Mcal/kg) content of the feed to equal the total calories per day. The mean within-horse Δ BW and Δ BCS from 0 to 42 days of each trial were evaluated using paired *t* tests. Trial 1 horses consumed 24.5 Mcal/d and BW increased ($P < .001$) by 24 ± 3 kg; however, there was no significant change in BCS (0.0 ± 0.5). Trial 2 horses consumed 22.8 Mcal/d and BW increased ($P = .009$) by 8 ± 3 kg and BCS tended to increase ($P = .06$) by 0.5 ± 0.5 . Trial 3 horses consumed 25.7 Mcal/d and BW and BCS increased ($P < .001$) by 22 ± 2 kg and 1.0 ± 0.5 , respectively. According to trial, horses required approximately 19, 34, and 18 Mcal/kg of weight gain, respectively. Additional factors affecting weight gain are related to the individual.

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1. Introduction

There are important welfare concerns for horses that are significantly underweight (body condition score [BCS] $< 2.5/9$) or overweight (BCS $> 7/9$) [1–5]. Several studies have investigated feeding regimens for horses to recover from starvation [1–5] and for overweight horses to lose weight [6–12]. The relationships among digestible energy (DE) intake, body weight (BW), and BCS have been described in horses being fed toward obesity [13–15]; however, there is limited data describing the relationships among DE intake, BW change, and BCS change in lean/moderate (BCS 4–5/9) condition horses. Data are important to add to the pool of knowledge about calorie intake required for gain; a

measure that has the potential to show considerable variation based on animal-related factors (i.e., maturity, initial body condition, and fitness) and feed composition [16–17]. The present study reports the DE intake of 35 horses over three, 42-day periods to provide insight into the relationship among DE intake, BW, and BCS in idle horses.

2. Material and Methods

The following experimental protocol was approved by the North Carolina State University Institutional Animal Care and Use committee (No. 13-126-O).

2.1. Animals and Physical Evaluation

The experiment was conducted in three separate feeding trials from March 25, 2014, to August 18, 2014, at the North Carolina State University Equine Research Unit in

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Raleigh, North Carolina. Thirty-five mature, idle, registered Quarter Horse geldings (mean \pm standard deviation; 5.3 ± 1.2 years; 462 ± 39 kg; BCS 4.5 ± 0.5) participated in one of three 42-day trials. Horses had unknown backgrounds except that the researchers were provided with pedigrees.

Body weight and BCS were measured at 7 AM on days –7, 0, 13, 27, and 41. Body weight was measured using an electronic large animal scale with ± 1.0 kg sensitivity (Smart Scale 200, Gallagher Animal Management, USA). Body condition scores were determined according to a 1- to 9-point scale [18] and performed by two experienced equine professionals (using whole units). The scores were averaged and represented in the nearest half or whole unit.

2.2. Animal Husbandry

Due to space limitations in the research facility, horses were split into three consecutive feeding trials. There were 12 horses in trial 1, 12 horses in trial 2, and 11 horses in trial 3. The horses in each trial were housed together in a large, dry lot pen with a lean-to shelter and free access to hay and water for approximately 14 days upon arrival to the facility, before the start of the study.

Following the 14-day acclimation period, the horses were housed in individual, partially covered, 3.7×12.2 m, dry lot pens with crushed limestone footing for 7 days prior to day 0 and for the remainder of the 42-day trial period. Each dry lot pen was equipped with an automatic watering trough, a 5-gallon feed bucket and a large hay bin. The pens were cleaned twice daily. The mean temperature for trials 1, 2, and 3 was 53°F , 74°F and 78°F , respectively.

Horses were maintained on a preventative health protocol, which included hoof care, dental examinations, teeth floating, and deworming, that were performed within 7 days prior to day 0 of each trial period. Horses were groomed weekly, and hooves were picked out every other day.

2.3. Dietary Protocol

Horses were fed weighed amounts of Orchard grass hay and whole oats twice daily at a DE intake rate that was above the National Research Council's 2007 Requirements for Maintenance [19]. The nutrient composition of the Orchard grass hay and whole oats for each trial is shown in Tables 1–4. Trial 1 horses were offered 2.00 kg DM/100 kg BW in Orchard grass hay and 0.2 kg DM/100 kg BW in whole oats daily. Trials 2 and 3 horses were offered 1.75–2.00 kg DM/100 kg BW in Orchard grass hay and 0.2 kg DM/100 kg BW in whole oats daily, depending on day 0 BCS. The whole oats were fortified to provide trace mineral supplementation. Two different lots of Orchard grass hay were used for the trials. Hay from one lot was designated for the morning feeding (AM), and the other lot was designated for the evening feeding (PM). Each lot of hay was sampled and analyzed for chemical composition at the start of the study. After the initial lots of hay ran out on day 23 of trial 3, a new lot of hay was tested and fed for the AM and PM feedings for the remainder of the trial.

Daily hay and oat rations were split equally and fed at 8 AM (AM) and 4 PM (PM) daily. The AM and PM hay rations

Table 1

Nutrient analysis for the whole oats and mixed grass hay for trial 1 (dry matter basis).

Items	Whole Oats	Orchard Grass Hay	
		AM	PM
Crude protein (%)	10.9	12.4	14.1
Acid detergent fiber (%)	14.4	32.2	33.2
Neutral detergent fiber (%)	27.0	51.6	50.6
Fat (%)	5.6	3.5	3.8
Ash (%)	4.4	6.5	6.8
Calcium (%)	0.18	0.76	0.96
Phosphorus (%)	0.42	0.34	0.33
Digestible energy (Mcal/kg) ^a	3.3	2.4	2.4

Abbreviations: AM, morning feeding; DE, digestible energy; PM, evening feeding.

^a DE (Kcal/kg dry matter) = $2,118 + 12.18 (\% \text{ crude protein}) - 9.37 \times (\% \text{ acid detergent fiber}) - 3.83 \times (\% \text{ hemicellulose}) + 47.18 \times (\% \text{ fat}) + 20.35 \times (\% \text{ nonstructural carbohydrate}) - 26.30 (\% \text{ ash})$ [20].

were weighed (#ES30R; Ohaus Corp, Parsippany, NJ, USA; 0.1 gram sensitivity) prior to feeding in the AM, and the PM hay allotment was stored in separate Rubbermade tubs until feeding. The whole oats were weighed prior to feeding using an electronic scale (Catapult 1000; Ohaus Corp, Parsippany, NJ, USA), with 0.01 gram sensitivity, and were stored in labeled plastic bags until feeding. Hay nets were used for messy horses, and orts were collected every evening at 10 PM and recorded.

Digestible energy intake (DEI) was calculated using the DE concentration of the feedstuffs provided by the laboratory chemical analyses from Dairy One (Ithaca, NY, USA) multiplied by the daily amount offered (kg) minus any refusal. The DE of the feed was estimated using the equation developed by Pagan: $\text{DE (Kcal/kg dry matter)} = 2,118 + 12.18 (\% \text{ crude protein}) - 9.37 \times (\% \text{ acid detergent fiber}) - 3.83 \times (\% \text{ hemicellulose}) + 47.18 \times (\% \text{ fat}) + 20.35 \times (\% \text{ nonstructural carbohydrate}) - 26.30 (\% \text{ ash})$ [20]. Weighed amounts of the feeds offered were recorded twice daily for each horse over the 42-day trial periods. The DEI was summed per day for 42 days per trial, and the mean DEI for each horse over the 42-day period was compared with the National Research Council 2007 Requirements for Maintenance [19].

Table 2

Nutrient analysis for the whole oats and Orchard grass hay for trial 2 (dry matter basis).

Items	Whole Oats	Orchard Grass Hay	
		AM	PM
Crude protein (%)	10.3	12.4	14.1
Acid detergent fiber (%)	16.0	32.2	33.2
Neutral detergent fiber (%)	30.5	51.6	50.6
Fat (%)	5.6	3.5	3.8
Ash (%)	4.4	6.5	6.8
Calcium (%)	0.11	0.76	0.96
Phosphorus (%)	0.38	0.34	0.33
Digestible energy (Mcal/kg) ^a	3.3	2.4	2.4

Abbreviations: AM, morning feeding; DE, digestible energy; PM, evening feeding.

^a DE (Kcal/kg dry matter) = $2,118 + 12.18 (\% \text{ crude protein}) - 9.37 \times (\% \text{ acid detergent fiber}) - 3.83 \times (\% \text{ hemicellulose}) + 47.18 \times (\% \text{ fat}) + 20.35 \times (\% \text{ nonstructural carbohydrate}) - 26.30 (\% \text{ ash})$ [20].

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