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Original Research

Influence of Feeding Horses a High Fiber Diet With or Without Live Yeast Cultures Supplementation on Feed Intake, Nutrient Digestion, Blood Chemistry, Fecal Coliform Count, and In Vitro Fecal Fermentation

Abdelfattah Z.M. Salem [a,*], Mona M.Y. Elghandour [a], Ahmed E. Kholif [b], Alberto Barbabosa [a], Luis Miguel Camacho [c], Nicholas E. Odongo [d]

[a] Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México, Toluca, México
[b] Dairy Science Department, National Research Centre, Giza, Egypt
[c] Unidad Académica de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Guerrero, Altamirano, México
[d] Department of Animal Sciences, School of Agriculture and Environmental Sciences, Pwani University, Kilifi, Kenya

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ABSTRACT

Sixteen Quarter Horse mares (body weight: 450–500 kg) were used in a complete randomized design to determine the effects of feeding horses a high fiber diet with or without yeast cultures addition on nutrient intake and digestion, blood chemistry, fecal coliform count, and in vitro fecal fermentation. The treatments were (1) a basal diet without yeast cultures addition (control treatment), (2) control diet plus Procreatin 7 at 15 g/mare/d (P7 treatment), (3) control diet plus Biocell F53 at 11 g/mare/d (F53 treatment), or (4) control diet plus Biosaf SC47 at 15 g/mare/d (SC47 treatment). The basal concentrate diet consisted of a mixture of 50% commercial concentrates and 50% wheat bran fed at 4 kg/mare and offered twice daily at 04:00 and 16:00 hours, while oat straw was offered ad libitum at 05:00 and 17:00 hours. The mares fed the F53 had higher ($P < .05$) oat straw and total nutrient intakes compared to the control diet. Addition of Biocell F53 and Biosaf SC47 yeast cultures increased ($P < .05$) all nutrients' digestibilities. Feeding the yeast cultures resulted in higher crude protein ($P = .029$), neutral detergent fiber ($P = .042$), and acid detergent fiber ($P = .035$) digestibilities compared to the control diet. The SC47 treatment had lower blood total protein ($P = .014$) than the control treatment. Higher ($P < .05$) asymptotic in vitro fecal gas production was obtained with F53 treatment compared to SC47 treatment without differences between F53, P7, and control treatments. Increased methane production was obtained ($P < .05$) with F53 and SC47 treatments compared to the control treatment. It can be concluded that daily addition of Biocell F53 yeast culture at 11 g/mare/d resulted in higher feed intake and nutrients digestibility without affecting the mare's health.

1. Introduction

Feeding high level of cereal grains in diets of horses is the main reason of various pathologies and feeding disorders [1]. Increasing dietary fiber at least 1% of the horse's body weight with decreasing starch and sugar levels can reduce such disorders [2]. Therefore, feeding adequate amounts of fiber feeds is required for normal digestive system function.

Fibrous feeds have low protein and low digestibility [3] implying there is need for developing new feeding strategies to meet horse requirements while maintaining gut health and integrity [4]. Similar to the rumen in ruminant

* Corresponding author at: Abdelfattah Z. M. Salem, Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México, 50000 Toluca, Mexico.
E-mail address: asalem70@yahoo.com (A.Z.M. Salem).

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animals, the large intestine of the horse is a large fermentation vat [5], which contains many species of microorganisms giving them the ability to use fibers by cecal and colon microbial fermentation to meet energy demands [6].

Feed additives are good strategies for improving feed utilization in horses. Dietary yeast supplementation in horses can influence nutrient digestibility and utilization in addition to altering microbial populations in the hindgut [4] on both a high-concentrate and high-fiber diets. *Saccharomyces cerevisiae* supplementation has positive effects such as increasing availability of nutrients in the diet [7], and decreasing the accumulation of lactate and pH resulting in a higher cellulolytic bacterial populations activity in the lower gut of the horse [8]. This practice would be favorable to horses consuming large amounts of starch, which would be easily converted to lactate inside the cecum and colon leading to gastric upset. The situation in case of high-fiber diets is not as clear as with low-fiber diets. Therefore, the aim of the present study was to evaluate the effect of feeding three different yeast cultures on nutrient digestion, blood chemistry, fecal coliform count, and in vitro fecal fermentation in horses fed a high fiber-based diet.

2. Materials and Methods

2.1. Treatments and Experimental Design

Sixteen Quarter Horse mares of 450- to 500-kg body weight and 10 to 12 years of age were used in this study, which lasted 15 days. The mares were assigned to four treatments in a complete randomized design with four mares each and were fed individually in 3.6 m × 3.6 m stalls. The mares were fed on a basal concentrate diet consisted of a mixture of 50% commercial concentrate (2 kg of total diet/mare; Pell Rol Cuarto de Milla, Mexico City, Mexico) and 50% wheat bran plus oat straw (2 kg of total diet/mare). The mares were fed the basal concentrate diet (i.e., 4 kg of total diet/mare) twice daily at 04:00 and 16:00 hours, whereas oat straw was offered ad libitum two times daily at 05:00 and 17:00 hours. Diets were balanced to meet daily mare's requirements according to nutrient requirements of horses of National Research Council [2]. The chemical composition (g/kg dry matter [DM]) of the concentrates mixture was: organic matter (OM) = 901.8, crude protein (CP) = 112.0, neutral detergent fiber (NDF) = 511.0, and acid detergent fiber (ADF) = 202.8. The chemical composition (g/kg DM) of oat straw was: OM = 929.4, CP = 26.7, NDF = 668.7, and ADF = 405.0; whereas the chemical composition (g/kg DM) of the wheat bran was: OM = 931.0, CP = 169.8, NDF = 460.0, and ADF = 131.2. During the experiment, the mares were given 3 to 4 hours in the stalls to allow sufficient time for feeding. During other periods (i.e., when not in the stalls), the mares were maintained on a drylot for socialization and exercise.

Three commercial cultures of *S. cerevisiae* (Lesaffre Feed Additives, Toluca, Mexico) were used, and the treatments comprised feeding the mares (1) a basal diet without yeast addition (control treatment), (2) the control diet plus Procreatin 7 at 15 g/mare/d (P7 treatment), (3) the control diet plus Biocell F53 at 11 g/mare/d (F53 treatment), and (4) the control diet plus Biosaf SC47 at 15 g/mare/d (SC47 treatment). Biocell F53 which contains a minimum guarantee of 2.0×10^{10} live yeast cells/g of *S. cerevisiae*, Procreatin 7 which contains a minimum guarantee of 1.5×10^{10} live yeast cells/g of *S. cerevisiae*, and Biosaf SC47 which contains a minimum guarantee of 1.5×10^{10} live yeast cells/g of *S. cerevisiae*. The daily yeast dose was mixed with 1 kg of the concentrate diet at 04:00 hours and left for mares for 1 hour before feeding the remaining amount of concentrate. Both of water and salt were available ad libitum.

2.2. Nutrient Digestibility

The amount of feed offered was recorded daily, and orts were collected and weighed daily throughout the experimental period. During the first 10 days (i.e., the adaptation period), the mares were trained for feed and fecal collections. On the last 5 days (i.e., the collection period), individual fecal samples were collected daily with rectal grab at 4-hour intervals and pooled for each mare. Daily pooled individual fecal samples were analyzed for proximate chemical composition and acid insoluble ash (AIA) concentrations. Moreover, feeds were sampled daily and stored for later proximate chemical analysis and estimation of AIA concentrations. Apparent nutrient digestibilities [9] were calculated using AIA concentrations according to the following equation (20 samples: 4 mares × 5 days):

$$\text{Apparent nutrient digestibility} = 100 - \left(100 \times \frac{\%AIA\ in\ feed \times \%component\ in\ feces}{\%AIA\ in\ feces \times \%component\ in\ feed}\right)$$

After ground through a Wiley mill (Arthur H. Thomas, Philadelphia, PA, USA) using a 2-mm screen, the samples (feed, orts, feces) were analyzed for DM (#930.15) and N (#954.01) as described by the Association of Official Analytical Chemists [10], and at the same time, they were analyzed for NDF and ADF according to Van Soest et al [11]. The samples of feed and feces were analyzed for AIA concentrations as described by Van Keulen and Young [12]. For analysis of total coliform count, at the day before experiment beginning and when no yeast was fed (i.e., day 0) and also on last day of the experiment (i.e., day 15), individual sample of rectal feces was collected, put into a clean and sealable plastic bags, and stored at 4°C until analysis.

2.3. Blood Sampling and Analysis

At the end of the experiment (i.e., day 15), all mares were sampled for blood by venipuncture from the jugular vein before feeding into a 10-mL clean dry vacutainer tube (Vacutainer; Becton, Dickinson and Co, Franklin Lakes, NJ, USA). The blood samples were allowed to stand for 5 minutes and centrifuged (Solbat J12, Solbat S.A. de C.V., México) at 4,000×*g* for 20 minutes. Obtained serum was separated into 2-mL clean dried Eppendorf tubes and frozen at −20°C until spectrophotometry analysis using a