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Productive and reproductive performance and metabolic profiles of ewes supplemented with hydroponically grown green wheat (*Triticum aestivum* L.)☆

M. Guerrero-Cervantes[a], M.A. Cerrillo-Soto[a], A. Plascencia[b], A.Z.M. Salem[c,*], A. Estrada-Angulo[d], F.G. Rios-Rincón[d], J.M. Luginbuhl[e], H. Bernal-Barragán[f], A.L. Abdalla[g]

[a] *Facultad de Medicina Veterinaria y Zootecnia, Universidad Juárez del Estado de Durango, Durango, Mexico*
[b] *Instituto de Investigaciones en Ciencias Veterinarias, Universidad Autónoma de Baja California, Mexicali, B.C., Mexico*
[c] *Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado de México, Toluca, Mexico*
[d] *Facultad de Medicina Veterinaria y Zootecnia. Universidad Autónoma de Sinaloa, Culiacán, Sinaloa, Mexico*
[e] *College of Agriculture and Life Sciences, North Carolina State University, USA*
[f] *Facultad de Agronomía, Universidad Autónoma de Nuevo León, Monterrey, Nuevo León, Mexico*
[g] *Centro de Energia Nuclear na Agricultura, Universidade de São Paulo, Brazil*

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ABSTRACT

Twenty six Katahdin ewes (i.e., female lambs from breeding to 2 mo of their 1st lactation) were used in a completely randomized design (13/treatment) to evaluate effects of replacement of dietary dry-rolled corn grain (DRC) and cottonseed meal (CSM) with hydroponically grown whole plant green wheat (HGW; *Triticum aestivum* L.) on productive parameters and blood metabolites during mating, gestation and lactation, and on body weight (BW) gain of their lambs in their 1st 60 days of age. The gestation diet contained 70% oat hay, 20% rolled corn grain and 10% cottonseed meal, while the lactation diet contained 50% oat hay, 20% DRC and 30% CSM. Treatments consisted of total replacement of DRC and CSM with HGW in the gestation diet, while in the lactation diet HGW replaced 100% of the DRC and 33% of the CSM. There were no diet effects on reproductive parameters, and substitution of DRC and CSM with HGW did not affect dry matter intake during gestation and lactation. The BW gain of the lambs that were fed HGW did not differ from controls in the first 2 months of gestation, while it was lower ($P < 0.05$) at the last 3 months of gestation. Feeding HGW did not affect birth BW of lambs or subsequent BW gains through 60 days of age. Plasma non-esterified fatty acids (NEFA) were not affected by the diets fed during gestation, but were 56% lower ($P < 0.05$) at day 60 of lactation. Plasma glucose was only lower ($P < 0.05$) at day 90 of gestation, and blood urea nitrogen was only lower ($P < 0.05$) at day 30 of lactation. There were no effects of diets on plasma insulin, cortisol or progesterone during gestation and lactation. Hydroponically grown green wheat is a suitable substitute for a portion of the DRC and CSM in ewes diets during gestation and lactation without negative effects.

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* Corresponding author.
E-mail addresses: asalem@yahoo.com, asalem70@hotmail.com (A.Z.M. Salem).

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1. Introduction

Inclusion of high levels of concentrate in the diets of late gestation and lactating ewes to improve productive and reproductive performance is a common practice. However cost-effective alternate feeding strategies for small ruminants must be developed and evaluated in order to counteract sustainability issues of feeding them concentrate feeds (Alexandre and Mandonnet, 2005).

Hydroponically grown green forages are a potential high feed quality feedstuff in arid and semiarid regions of the world (Al-Faraki and Al-Hashimi, 2012). The nutritive value and fermentative characteristics of hydroponically grown forages positively influenced the performance of late gestation and lactating ewes (Herrera et al., 2010; Gebremedhin, 2015). Earlier investigations emphasized effects of dietary quality on endocrine and metabolic profiles in ewes during pregnancy and lactation (Lemley et al., 2014; Vonnahme et al., 2013). However adequate nutritional status of ewes is associated with favorable productive and reproductive performance whereby blood glucose, non-esterified fatty acids (NEFA) and blood urea nitrogen (BUN) are utilized to sustain a desirable protein and energy balance in ewes during gestation and lactation (Hatfield et al., 1999). Changes in metabolic hormones, such as insulin, play an important role in metabolic adaptation to changes in body weight (BW) and body condition while providing diagnostic information to evaluate ewe nutritional status (Caldeira et al., 2007). Cortisol may be particularly important in this regard as it is the predominant glucocorticoid in sheep blood and has been used as a reliable physiological endpoint to determine ewe responses to a variety of physiological, physical and environmental stress (Moolchandani et al., 2008).

A paucity of information is available with respect to the metabolic profile and performance during mating, gestation and lactation of ewes fed diets containing hydroponically grown green wheat (HGW). Thus this experiment was conducted to determine effects of replacement of dry-rolled corn (DRC) and cottonseed meal (CSM) by HGW in an oat hay-based diet on the metabolic profile as well as the productive and reproductive performance of Katahdin female lambs.

2. Materials and methods

2.1. Study site

Animal management procedures were within guidelines of locally approved techniques for animal use and care. The experiment was conducted at the experimental facilities of the Facultad de Medicina Veterinaria y Zootecnia of the Universidad Juárez del Estado de Durango (México), located at 24°28′N and 104°40′W and at an altitude of 1890 m. The climate is classified as Bs1 (k)(w), considered as dry temperate with a mean annual temperature and rainfall of 17.5 °C and 450 mm, respectively.

2.2. Production of hydroponic green wheat

Wheat seeds (variety Anahuac) were rinsed three times with water, disinfected with a 5% sodium hypochlorite solution, soaked in water for 24 h in a plastic container, and transferred to a perforated container for 24 h. Seeds were sown in 40×40 cm perforated plastic trays using 800 g of germinating seeds per tray, which were then placed in a 5.25×5.25 m greenhouses. Growing forage was irrigated 5 times/day for 2 min. The green wheat forage was harvested 10 d post- germination (Herrera et al., 2010).

2.3. Animals, management, and treatments

Katahdin ewes (i.e., female lambs from breeding to 2 mo of their 1st lactation; hereafter referred to simply as 'ewes' to differentiate them from their lambs which are referred to as 'lambs') with an initial BW of 32.4 ± 3.3 kg and 9.0 ± 1.5 mo of age were fed for 8 mo in order to evaluate inclusion of HGW during mating, gestation and lactation. The experiment consisted of 1 mo of mating, 5 mo of gestation and 2 mo of lactation. Three weeks previous to start the experiment, all ewes were dewormed (Valbazen, Pfizer®, Mexico City, Mexico) and injected with 1×10^6 IU vitamin A (Synt-ADE, Fort Dodge Animal Health, México).

To synchronize estrus, the ewes were treated with intra-vaginal sponges containing 65 mg medroxy-progesterone. When the sponge was removed after 14 d, 400 IU PMSG (Folligon®: Shering-Plough Animal Health) were administered intramuscularly. After that, ewes were divided into 4 groups and exposed to 4 Katahdin rams (i.e., 1 ram/group). Rams were marked on the chest with a colored crayon to monitor and record mating. Once mating was completed, ewes were randomly divided into 2 groups of 13 and housed in individual 2×1 m pens with continuous access to water and a supplement of vitamins and minerals.

Two types of diets were fed during the experiment, being a gestation diet during mating and gestation, and a lactation diet during the 2 mo of lactation. The gestation diet contained (g/kg DM): 700 oat hay, 200 DRC, 100 CSM, while the lactation diet contained (g/kg DM): 500 oat hay, 200 DRC, 300 CSM. The HGW diet during gestation (HGW-G) consisted of total replacement of DRC and CSM by 300 g/kg DM of HGW (corresponding to 2 kg as fresh HGW). Similarly, during lactation (HGW-L), 300 g/kg DM of HGW (2 kg as fresh) was totally replaced with DRC and partially with CSM (i.e., 100 g/kg DM of 300 g/kg DM). The dietary ingredients and experimental diets are in Table 1.