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Short communication

The potential use of layer litter in Awassi lambs' diet: It's effects on nutrient intake, digestibility, N balance, and growth performance

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ABSTRACT

The objective of this study was to evaluate the effects of feeding layer hen litter (LL) at various levels on nutrient intake, digestibility, N balance and growth performance of Awassi ram lambs. Forty two Awassi lambs [initial body weight (BW) = 20.5 ± 0.88 kg; age 70 ± 2.02 days] were randomly assigned to three isonitogenous fattening diets for 75 days. The LL was included in the diets at 0 (LL0; n = 14), 150 g/kg (LL150; n = 14), and 300 g/kg (LL300; n = 14) of dietary dry matter (DM) to replace part of the soybean meal and barley grain. On day 50 of the fattening period, 6 animals from each group were randomly selected and housed individually in metabolism crates (1.05 × 0.80 m) to evaluate nutrient digestibility and N balance. Intake of DM (DMI) was greater ($P < 0.05$) for LL150 diet than for LL0 diet, whereas LL300 diet was intermediate. Intake of organic matter and crude protein was similar among diets. Neutral detergent fiber and copper intake were the highest for lambs fed LL300 diet followed by LL150 diets and LL0 diets. Acid detergent fiber intake was greater ($P < 0.05$) for lambs fed LL diets compared to LL0 diet. No significant differences were observed in nutrient digestibilities among treatments. The N retention was greater ($P < 0.05$) in lambs fed LL150 diet than in lambs fed LL0 diet, whereas LL300 diet was intermediate. Final BW and average daily gain (ADG) were greatest ($P < 0.05$) in lambs fed LL150 diet. Feed efficiency (ADG:DMI) was improved in lambs fed the LL150 diet compared to LL0 diet. Cost of gain was lower ($P < 0.05$) for diets containing LL than the LL0 diet. Feeding Awassi lambs finishing diets containing layer hen litter at 150 g/kg improved growth performance and lowered the cost of production.

1. Introduction

The profitability of meat animal agricultural industries is directly related to production efficiency. Most of the production cost of red meat is related to feed, thus necessitating the need to find alternative feed sources to reduce the overall production cost (Awawdeh, 2011). Layer hen litter (LL) is a potential candidate for use as an alternative feed (Talib and Ahmed, 2008). It is composed of excreta, feathers, wasted feed, bedding materials, and broken eggs residues (Jordaan, 2004) making it a valuable source of nitrogen and minerals and a moderate source of energy (Animut et al., 2002; Jackson et al., 2006), which makes it a good source of nitrogen to ruminants. Elemam et al. (2009) found that feeding deep stacked poultry litter to lambs at 150 and 300 g/kg of dietary dry matter (DM) did not affect DM intake, but at 450 g/kg level it increased DM intake. The cost of body weight gain decreased as the poultry litter levels increased up to 300 g/kg DM (Elemam et al., 2009). Obeidat et al. (2011) found that average daily gain and feed conversion ratio were not affected when feeding broiler litter to Awassi lambs at 100 and 200 g/kg DM compared with the control diet. In another study, Talib and Ahmed (2008) indicated that apparent digestibility values for DM and OM tended to be lower for sheep fed diets containing 360 g/kg DM broiler litter than diets containing 0, 120 or 240 g/kg DM broiler litter. Similarly, CP digestibility for 360 g/kg DM broiler litter-diet was lower than the other treatments (Talib and Ahmed, 2008). Our hypothesis was that replacing soybean meal and barley grain, the most expensive ingredients, with LL during the growing period would decrease the cost of gain without affecting nutrient intake and growth performance of Awassi lambs. This study was conducted to evaluate the effect of feeding LL on nutrient intake, digestibility, N balance and growth performance of Awassi ram lambs.

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Table 1
Ingredients and chemical composition of diets fed to Awassi lambs.

Item	Diets[a]		
	LL0	LL150	LL300
Ingredients (g/kg DM)			
Barley grain	629	519	409
Soybean meal, 440 g/kg CP (solvent)	150	110	70
Layer litter	0	150	300
Wheat straw	200	200	200
Soybean oil	5	5	5
Salt	7.5	7.5	7.5
Limestone	7.5	7.5	7.5
Mineral vitamin premix[b]	1	1	1
Feed cost/ton (US$)	388	326	263
Nutrients			
Dry matter, g/kg DM	909	907	916
Organic matter, g/kg DM	926	890	878
Crude protein, g/kg DM	173	174	174
Neutral detergent fiber, g/kg DM	226	254	274
Acid detergent fiber, g/kg DM	117	142	154
Ether extract, g/kg DM	69	66	65
Copper (μg/g)	4.86	8.76	14.18

[a] Diets were: layer litter (LL) included in the diets at 0 (LL0), 150 (LL150), and 300 g/kg (LL300) of dietary dry matter.
[b] Composition per kg use (vitamin A, 2,000,000 IU; vitamin D_3, 40,000 IU; vitamin E, 400 mg, Mn, 12.80 g; Zn, 9.00 g; I, 1.56 g; Fe, 6.42 g; Cu, 1.60 g; Co, 50 mg; Se, 32 mg).

2. Materials and methods

2.1. Fattening, digestibility and N balance procedures

Jordan University of Science and Technology (JUST) Institutional Animal Care and Use Committee approved all procedures used in this study. This experiment was conducted at the Agricultural Research and Training Unit (ARTU) at JUST.

In a completely randomized design experiment, forty two Awassi lambs (70 ± 2.02 days of age; 20.5 ± 0.88 kg initial body weight; BW) were allocated randomly to one of three diets. Layer hen litter was included in the diets at the levels of 0 g/kg (LL0), 150 g/kg (LL150) and 300 g/kg (LL300) of dietary dry matter (DM). Layer litter was obtained from a local floor-reared laying hen farm. Before mixing the diets, LL was placed in plastic bags and autoclaved at 121 °C for 20 min to kill litter microflora. After autoclaving, LL was ground to pass a 3 mm screen in order to facilitate its mixing with the other dietary ingredients (Table 1). The LL contained 895, 725, 289, 236, and 97, and 25 g/kg DM, organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and ether extract (EE), respectively. In addition, LL was analyzed for copper content and contained 41.59 mg/kg DM (AOAC, 1997). All diets were formulated to be similar in CP content (174 g/kg CP; DM basis) and to meet the requirements for fattening Awassi lambs (NRC, 2007). Lambs were housed individually in shaded pens (1.5 × 0.75 m), and fed twice daily (two equal meals at 0900 and 1400). An adaptation period of one-week was allowed prior to the experimental period. The study lasted for 75 days. At the beginning of the study, all lambs were treated for internal parasites.

The experimental diet was offered *ad libitum* as a total mixed ration. Water was offered with free access throughout the experiment. Feed refusals were weighed daily throughout the study, sampled and stored at −20 °C for chemical analysis. At the end of the study, refusals were composited for each lamb and chemically analyzed to be used to calculate DM intake. Upon mixing of diets, random samples of offered feeds were collected and saved at −20 °C until analysis. At the end of the study feed samples were combined for each dietary treatment and then chemically analyzed. The DM and other nutrients intake were measured by the difference between the offered and refused feed. Lambs were weighed at the beginning of the experiment and subsequent weights were recorded weekly before the morning feeding throughout. Average daily gain was calculated by dividing the difference between the final and the initial BW by the duration of the study. Feed costs were calculated based on the current prices of diet ingredients of the year 2015 (Table 1). The price of LL estimated based on the collecting, autoclaving and grinding. Other costs were similar among the different diets.

On day 50 of the fattening period, 6 lambs from each group were selected randomly and housed individually in metabolism crates (1.05 × 0.80 m) to evaluate nutrient digestibility and N balance. Lambs were allowed a period of 5 days to adapt to the crates followed by a collection period of 5 days where feed intake and refusals were recorded and sampled for further analysis. Daily fecal output was collected, weighed, and recorded, and then 10% was kept for subsequent analyses. Using plastic containers, urine was collected, weighed, and recorded, and then 5% was kept to evaluate N retention. Each container had 50 mL of 6 N HCl to prevent ammonia losses. Fecal samples were dried at 55 °C in a forced-air oven to reach a constant weight, air equilibrated, and then ground to pass through 1 mm sieve and kept for further analysis. Feed, refusals, and feces were analyzed for DM, OM, CP, NDF, ADF, and EE. Lambs were then returned back to the individual pens till the end of the fattening study.

2.2. Chemical composition

Composited diets and refusal samples were dried at 55 °C in a forced-air oven to reach a constant weight, air equilibrated, ground to pass through 1 mm sieve (Brabender OHG Kulturstrase, Duisburg, Germany) and kept for further analysis. Layer litter, diets, and refusals were analyzed following AOAC, 1997 procedures for DM (100 °C in air-forced oven for 24 h), OM (550 °C in ashing furnace for 6 h), CP (Kjeldahl procedure) and EE (Soxtec procedure, SOXTEC SYSTEM HT 1043 Extraction Unit, TECATOR, Box 70, Hoganas, Sweden). Additionally, samples were analyzed for NDF and ADF according to the procedure described by Van Soest et al. (1991) with modifications for use in the ANKOM^{2000} fiber analyzer apparatus (ANKOM Technology Cooperation, Fairport, NY). The NDF and ADF analysis was performed using sodium sulfite and a heat stable alpha amylase and expressed with residual ash content. Copper content was analyzed in LL and in all diets according to procedures described by AOAC (1997).

2.3. Statistical analysis

All data were analyzed using the MIXED procedure of SAS (version 8.1, 2000, SAS Institute Inc., Cary, NC) where lamb was the random variable. For all data, treatment was the fixed effect. Initial body weight was used as a covariate for analyzing differences in body weight gain. Least square means of the MIXED procedures of SAS was used to further identify significant differences among means. Significant differences were considered at ($P < 0.05$).

3. Results

Replacing part of the barley grain and soybean meal with LL reduced the cost of diets by 16 and 32 percentages for the LL150 and LL300 diets, respectively (Table 1). Dry matter intake was greater ($P < 0.05$) for lambs fed the LL150 diet than the LL0 diet; whereas LL300 diet was similar to the other two diets (Table 2). Organic matter, EE and CP intake did not differ among diets. Neutral detergent fiber and Cu intake was highest ($P < 0.05$) for lambs fed the LL300 followed by the LL150 and LL0 diets. Acid detergent fiber intake was greater for LL containing diets than the control diet.