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# Partial substitution of barley grain with *Prosopis juliflora* pods in lactating Awassi ewes' diets: Effect on intake, digestibility, and nursing performance

B.S. Obeidat*, M.M. Shdaifat

*Department of Animal Production, Faculty of Agriculture, Jordan University of Science and Technology, Irbid 22110, Jordan*

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ABSTRACT

A study was conducted to evaluate the effects of feeding *Prosopis juliflora* pods (PJP) on performance of nursing Awassi ewes and their lambs. Thirty Awassi ewes and their lambs were randomly assigned to one of the three dietary treatments being no PJP (PJP0; $n = 10$), 125 g/kg PJP (PJP125; $n = 10$), and 250 g/kg PJP (PJP250; $n = 10$) of the diets offered *ad libitum* in replace of the barley grain. The study lasted for 8 weeks. No differences occurred ($P > 0.05$) in dry matter (DM), organic matter (OM), crude protein (CP), and metabolizable energy (ME) intake among groups. However, neutral detergent fiber (NDF) was higher ($P < 0.05$) for PJP250 than PJP0 diet, while PJP125 group was intermediate. Moreover, acid detergent fiber (ADF) intake was the highest ($P < 0.05$) in the PJP250. Intakes of NDF and ADF also increased linearly ($P < 0.05$) with increasing PJP content. Digestibility of DM, OM, CP, and NDF was similar among diets but ADF digestibility was lower ($P < 0.05$) in the PJP250 than the PJP0 diet. There were no differences in final body weight (BW) of ewes among groups. Awassi ewes fed the PJP0 diet lost less ($P < 0.05$) BW than ewes fed the PJP125 and PJP250 diets. Lambs fed the PJP125 and PJP250 diets had higher ($P < 0.05$) weaning BW and average BW gain than the PJP0 treatment group. Similarly, weaning BW and average BW gain increased linearly ($P < 0.05$) with increasing PJP content. Ewes fed the PJP250 diet had higher ($P < 0.05$) milk production than ewes fed the PJP0 and PJP125 diets with no differences among treatment groups in total solids, fat and protein content. Awassi ewes that received PJP250 diet had lower ($P < 0.05$) kilogram DM intake: kilogram milk production than PJP0, while PJP125 group was intermediate. Cost/kg milk production (US$) was the highest ($P < 0.05$) in PJP0 group compared with PJP125 or PJP250 groups. Results demonstrate the potential of including PJP as a feed ingredient for nursing Awassi ewes and their lambs due to the reduction in feed cost and the improvement in milk production.



## 1. Introduction

Plant-based feeds (such as soybean meal, barley grain, wheat bran and corn grain) are known to be the best nutrient sources, and are extensively used in livestock rations in Jordan. However, due to the high cost of these feeds, livestock producers use agro-industrial byproducts and/or unusual feeds such as *Prosopis juliflora* pods (PJP). These alternative feeds may be economically advantageous in reducing feeding costs and can play an important role in feeding of sheep and goats under various management systems.

*P. juliflora* is a leguminous tree native to arid and semi-arid regions (Pasiecznik et al., 2001). The crude protein (CP)

* Corresponding author at: Department of Animal Production, Faculty of Agriculture, Jordan University of Science and Technology, P.O. Box 3030, Irbid 22110, Jordan. Tel.: +962 2 7201000x22214; fax: +962 2 7201078.
*E-mail address:* bobeidat@just.edu.jo (B.S. Obeidat).

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and metabolizable energy (ME) contents of PJP are similar to those of barley grain (Obeidat et al., 2008). Studies on sheep have shown that replacing wheat bran or barley and corn grains with PJP improved dry matter (DM) intake, average body weight (BW) gain, and feed efficiency (Ravikala et al., 1995; Abdullah and Abdel hafes, 2004; Obeidat et al., 2008). Similarly, Habit and Saavedra (1988) found that PJP can replace up to 600 g/kg of wheat grain in rations of lactating cows and that DM intake, BW gain and milk production increased with an increasing proportion of pods in the diet. However, no such data is available in evaluating the effects of feeding *P. juliflora* pods on Awassi sheep performance and productivity during the first part of lactation, and on the growth of their lambs.

Therefore, the objective of this experiment was to evaluate the effects of partially replacing barley grain by *P. juliflora* pods on nutrient intakes, milk production and composition (*i.e.*, total solids, CP, and crude fat) of Awassi ewes, as well as the performance of their lambs from birth to weaning.

## 2. Materials and methods

### 2.1. Experimental design, animals and diets

This experiment was conducted at Al-Khanasry Station for Livestock Research, National Center for Agricultural Research and Extension (NCARE) in Jordan. The Station is located 50 km to the North of Amman at 31.5°N latitude and at an altitude of 350 m, with an arid to semi-arid climate and annual rainfall of 170 mm. Jordan University of Science and Technology Institutional Animal Care and Use Committee approved all procedures used in this study.

Sixty ewes were estrually synchronized using intravaginal medroxyprogesterone acetate sponges (60 mg; Veramix, Pharmacia & Upjohn Co., Orangeville, Canada) to ensure lambing uniformity of the experiment animals. Of those that lambed, thirty ewes (initial BW, 64.1 ± 3.10), and their lambs (initial BW, 4.4 ± 0.17) were selected for the experiment based on lambing date. Ewes used in the experiment aged 4–6 years and parity ranged from 3 to 5. The selected ewes were examined by a veterinarian to assure good health and udder status. All ewes were nursing single lambs. Ewes and their lambs were randomly assigned to one of the three treatments: 0 PJP (PJP0; $n = 10$), 125 PJP (PJP125; $n = 10$), and 250 g/kg PJP (PJP250; $n = 10$) in replacement of barley grain in the diets (Table 1). To meet NRC (2007) requirements for lactating ewes, diets were formulated to be isonitrogenous. Ewes with their lambs were housed individually in shaded pens (1.5 m × 0.75 m) and fed their diets daily at 8:00 h. Experimental diets contained 145 g/kg CP which is adequate for nursing ewes (NRC, 2007). The selected ewes were given 1 week adaptation to the pens and to the experimental diets. Following adaptation, the assigned diets were fed to the ewes and their lambs for 7 weeks. Ewes and lambs were weighed separately biweekly before feeding throughout the study.

Ewes and lambs were fed their diets *ad libitum* and on the basis of the animals established consumption pattern during adaptation period and had access to fresh water throughout the experiment. To measure nutrient intakes, orts were collected daily and sampled for chemical analysis. Feed buckets were managed to let no more than 10% of feed per animal to remain 1 h prior to feeding and if the feeders found empty, 10% of feed was added to the previous amount offered on the day before the next voluntary feed intake.

*P. juliflora* pods were collected near the Jordan valley and allowed to air dry before passing them through a rotating blade forage chopper to reduce the size to 2–4 cm pieces before adding into the diets to ensure thorough mixing and to avoid selection. The nutrient contents of PJP were 926, 951, 126, 329, and 205 g/kg for DM, organic matter (OM), CP, neutral detergent fiber (NDF), and acid detergent fiber (ADF), respectively. The feed cost was calculated based on prices of diet ingredients of the year 2011 (Table 1) and used to calculate the cost of milk production. The cost of making 1 ton of the study diets was US $403, $370 and $337, for the PJP0, PJP125, and PJP250 diets, respectively. Additionally, the cost of produced milk (US$/kg of produced milk) was calculated by multiplying the cost of offered daily feed by the feed efficiency. Feed efficiency was calculated by dividing DM intake by milk production.

At the end of the study, 6 ewes from each group were chosen at random and housed individually in digestibility crates to determine nutrient digestibility. Ewes were allowed a 4 d adaptation period to the crates followed by a 4 d collection period during which feed intake and orts were recorded and fecal output was collected, weighed and recorded. Daily 10% of each was kept and pooled for subsequent chemical analysis by ewe. Composited diets ($n = 3$), orts and fecal samples were dried at 55 °C in a forced air oven to constant weight, air equilibrated and then ground to pass a 1 mm screen (Barbender Ohg Duisdurg, Kulturstrase 51–55, type 880845, Nr 958084, Duisdurg, Germany) and kept for further analysis. Ground samples were analyzed for DM (100 °C in air-forced oven for 24 h; method 967.03), ash (550 °C in ashing furnace for 6 h; method 942.05), and N (Kjeldahl procedure; method 976.06) of AOAC (1990). In addition, all samples were analyzed for NDF and ADF according to procedures described by Van Soest et al. (1991) with modifications for use in the Ankom$^{2000}$ fiber analyzer apparatus (Ankom Technology Corporation, Macedon, NY, USA). Neutral detergent fiber analysis included sodium sulfite and a heat stable alpha amylase. Both NDF and ADF are expressed with residual ash content.

### 2.2. Milk production and chemical composition

During the second week of lactation, milk production measurements were made and continued biweekly thereafter. Milk production over a period of 12 h was estimated biweekly throughout the study at 08:00 h by hand milking. Lambs were separated from their dams 12 h before milking. Then, milk production was calculated over 24 h (Awawdeh et al., 2009). For chemical composition of milk, a 125 ml sample was collected biweekly from each ewe and frozen at −20 °C for later analysis. At the end of the experiment, milk samples were thawed and bulked for each ewe. Then, milk samples were analyzed for total solids (TS), fat and CP. Total solids were determined using a forced air oven at 50 °C to constant weight, then at 100 °C for 24 h. Crude protein ($N \times 6.38$) was determined using a Kjeldahl procedure (method 976.06; AOAC, 1990). Fat content was analyzed according to Gerber method (Gerber Instruments, K. Schnider and Co. AG; 8307 Langhag, Effretikon). Milk energy value (Mcal/kg or Mcal/d) was calculated based on the following equation that was adapted from NRC (2001): milk energy value (Mcal/kg of milk) = (0.0929 × g/100 g fat) + (0.0547 × g/100 g CP + 0.192).

### 2.3. Statistical analysis

Data analyses used the mixed procedure of SAS (2000) in a completely randomized design. Milk production was analyzed as repeated measures in a model including treatment, week, and the treatment × week interaction (*i.e.*, wk 2, 4, 6, 8). Because no treatment × week interaction was detected, only the main effect was discussed. For diets, milk composition and yield, nutrient intakes, ewe and lamb BW the only fixed effect was treatment. Furthermore, the main effect was tested for linear and quadratic effect. A probability of $P \leq 0.05$ was considered as a significant difference.

## 3. Results

### 3.1. Diets, nutrient intakes and digestibility

The content of OM was higher ($P < 0.05$) in PJP diets when compared to the PJP0 diet (Table 1). The PJP250 diet had the highest NDF and ADF contents while the PJP0 had the lowest ($P < 0.05$) with the PJP125 being intermediate.

Results of nutrient intakes of Awassi ewes fed PJP are presented in Table 2. There were no differences in DM, OM, CP, and ME intakes among treatment groups. Similarly, no linear ($P > 0.19$) and quadratic ($P > 0.20$) effect was observed among groups. However, neutral detergent fiber (NDF) was greater ($P < 0.05$) for PJP250 than PJP0 diet, while PJP125 group was intermediate. Moreover, ADF intake was much greater ($P < 0.05$) for the PJP250 than the PJP0 and PJP125