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Performance of Nursing Awassi Ewes Fed Different Levels of Bread By-product

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ABSTRACT: Objective of this experiment was to evaluate the effect of partial substitution of barley grain with bread by-product (BB) on performance of Awassi ewes and their lambs. Forty Awassi ewes rearing single lambs were randomly allotted into four experimental diets containing various levels of BB. The experimental diets contained 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of BB on dietary dry matter (DM). The study lasted for eight weeks, in which the first week was used as an adaptation period and seven weeks of data collection. Ewes and their lambs were penned individually where they were fed their lactating diets *ad libitum*. Ewes and lambs body weights were measured at the beginning and at the end of the experiment. However, milk production and composition were evaluated biweekly. Feeding BB had no effect (p>0.05) on dry matter (DM), organic matter (OM), and crude protein (CP) intakes. However, neutral detergent fiber (NDF) intake was the lowest (p<0.05) for the BB20 and BB15 diets followed to BB10 diet (i.e., 640, 677, 772 g/d, respectively) while the highest NDF intake was for the BB0 diet (i.e., 825 g/d). Similarly, NDF intake decreased linearly (p<0.001) as the BB content increased. Acid detergent fiber (ADF) intake was highest (p<0.05) for the BB0 and BB10 diets (425 and 416 g/d, respectively) followed by the BB15 and BB20 diets (359 and 342 g/d, respectively). Moreover, a linear (p<0.001), quadratic (p = 0.04), and cubic (p = 0.04) effects were observed in ADF intake among diets. Nutrient digestibility was similar among different diets. Bread by-product had no effect (p>0.05) on ewes body weight change and on lamb performance (i.e., weaning body weight and average daily gain). Similarly, no differences (p>0.05) were observed either in milk production or composition by the BB substitution. Inclusion of BB reduced feed cost by 9, 14, and 18% for the BB10, BB15, and BB20 diets, respectively. No differences were observed in milk efficiency (DM intake: milk production; p>0.05) among diets. However, cost of milk production ($US/kg milk) was the lowest (p<0.05) in the diet containing BB20. Results of the present study indicate that feeding bread by-product up to 20% of the diet DM had no effect on performance of Awassi ewes and their lambs and reduced feed cost. (**Key Words:** Awassi Ewes, Bread by Product, Nutrient Intake, Nutrient Digestibility, Milk Production)

INTRODUCTION

In Jordan, using agricultural and industrial by-products in feeding livestock has increased tremendously (Hindiyeh et al., 2011; Obeidat et al., 2011; Obeidat and Gharaybeh, 2011) due to the shortage of conventional feedstuffs such as barley grain. Barley grain is one of major sources of energy that used in all ruminant diets in Jordan. However, due to large increase in international demand, the price of barley grain increased ominously putting economical pressure on livestock producers. Therefore, extensive research interests have been carried on to investigate the possibility of feedstuff alternatives in feeding livestock such as bread by-product (BB). Bread by-product is composed of many things that are not consumed by humans. Usually, BB is cheap to purchase with drying is the most important added cost when used in livestock feeding. Recently, Hindiyeh et al. (2011) found that inclusion of BB in Awassi lamb diets decreased nutrient intake while reduced the cost of gain when fed to fattening Awassi lambs at levels of 30% of the diet DM. However, few studies were done on the use of BB in Awassi ewes feeding. The objective of this study was to investigate the effects of partial substitution of barley grain with bread by-product on performance of Awassi ewes and their lambs.

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MATERIALS AND METHODS

Diets, animals, and experiment procedures

This experiment was conducted at the Agriculture Center for Research and Production at Jordan University of Science and Technology. Jordan University of Science and Technology Institutional Animal Care and Use Committee approved all procedures used in this experiment.

Using a complete randomized design, forty Awassi ewes (initial BW, 56.1±1.94 kg) were assigned into four nursing diets. Bread by-product was included in the diets at levels of 0 (BB0), 10 (BB10), 15 (BB15) or 20% (BB20) of dietary dry matter (DM) as a substitute of barley grain. Bread by-product was obtained from the Jordan university of Science and Technology restaurants. Before mixing, BB was sun dried for three days and ground to pass 3 mm screen in order to ease the mixing process with the other dietary ingredients. The BB used in the current study contained 91.5, 97.5, 12.2, 2.4, and 0.61%, DM, organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF), respectively (on DM basis). The BB also contained 3.25 Mcal/kg (NRC, 2001). All diets were formulated to be similar in CP content (15.1% CP; DM basis; Table 1) and to meet the requirements for nursing Awassi ewes (NRC, 2007). Ewes and their lambs were housed individually in shaded pens (1.5 m×0.75 m), and fed once daily at 0900. An adaptation period of one week was allowed prior to the experimental period, and the study lasted eight weeks.

The experimental diets were offered *ad libitum* as a total mixed ration. Animal had free water access throughout the experiment. Feed refusals were weighed daily and stored at -20°C until chemical analyses were performed. Ewes and their lambs were weighed at the commencement and at the termination of the experiment. Body weight change was calculated by calculating the difference between the final body weight and the initial body weight.

To evaluate the nutrient digestibility, four ewes were randomly selected from each group and housed individually in metabolism crates (1.05×0.80 m). Ewes were allowed a period of four days to adapt to the crates followed by a 5 d collection; where feed intake and refusals were recorded and sampled. Daily fecal output was collected, weighed, and recorded, and then 10% was kept at -20°C until the end of the collection period.

Composited diets, refusal, and fecal 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, Duisdurg, Germany) and kept for further analysis. Following AOAC (1990) procedures, BB, diets, refusals, and feces were analyzed for DM (100°C in air-forced oven for 24 h), OM (550°C in ashing furnace for 6 h), and CP (Kjeldahl procedure). Samples were also 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, USA). Analysis of NDF was performed using sodium sulfite and a heat stable alpha amylase and

Table 1. Ingredients and nutrient content of nursing Awassi diets contained various levels of bread by-product

Items	Diets[1]			
	BB0	BB10	BB15	BB20
Ingredients (% DM)				
Barley	50	40	35	30
Bakery waste	0	10	15	20
Soybean meal	15	15	15	15
Wheat hay, chopped	32	32	32	32
Salt	1.5	1.5	1.5	1.5
Limestone	1.4	1.4	1.4	1.4
Mineral and vitamins[2]	0.1	0.1	0.1	0.1
Cost ($US/Ton)	306	278	264	250
Nutrient composition				
Dry matter (%)	91.5	91.8	91.4	91.7
Organic matter (% of DM)	90.3	90.4	90.9	91.3
Crude protein (% of DM)	15.0	15.1	15.2	15.1
Neutral detergent fiber (% of DM)	36.2	33.2	30.1	28.7
Acid detergent fiber (% of DM)	18.7	17.8	16.0	15.3
Metabolizable energy (Mcal/kg)[3]	2.49	2.50	2.51	2.52

[1] Diets: bread by-product (BB) included in the diets at 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of dietary dry matter.
[2] Composition per 1 kg contained (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).
[3] Calculated according to tabular values of NRC (2001).

expressed with the residual ash content.

Milk production and composition

During the second week of lactation, milk production measurements were started after the adaptation period and then biweekly hereafter (i.e., wk 2, 4, 6 and 8). For all ewes, milk production over a period of 12 h was estimated throughout the study at 0800 h using hand milking. Lambs were separated from their dams 12 h before milking. Milk production was then calculated over the 24-h period (Awawdeh et al., 2009). For chemical composition of milk, 125-ml sample was collected from each ewe and was analyzed immediately for total solids (TS), fat, and protein. Total solids, CP, and fat were analyzed according to the AOAC (1990). Total solids were evaluated using an air-forced oven at (50°C) to reach a constant weight, then at (100°C) for 24 h. Crude protein was evaluated using Kjeldahl procedure (N*6.38) while fat content was analyzed according to Gerber method (Gerber Instruments, K. Schnider and Co. AG; 8307 Langhag, Effretikon; Obeidat et al., 2012).

Statistical methods

A linear mixed model analysis was used to analyze milk production data (SAS, 2000). Diet, week, and their interaction were considered as fixed effects and animal within diet was incorporated in the model as a random effect while week as a repeated measure. Because there was no week×diet interaction detected, the diet effect was discussed. The rest of the data was analyzed with the treatment as the main effect. Initial body weight of ewes and milk production during the first week as well as birth weight of lambs were used as a covariate in the model. Additionally, the main effect was tested for linear, quadratic, and cubic effect. Significant differences were declared at $p<0.05$.

RESULTS AND DISCUSSION

The nutrient composition of the experimental diets is shown in Table 1. The major restriction of feeding BB to livestock is the variation in the chemical composition as reported in the literature (Guiroy et al., 2000). According to NRC (2001) the BB contained 15, 8.9, and 3.1% CP, NDF, and ADF, respectively. However, these nutrients were different from reported values (Arosemena et al., 1995) which were 12.29, 11.86, and 4.95% respectively. In the current study, the differences in chemical composition of BB were also observed compared to those reported by the NRC (2001). The differences in bread by-product (i.e., bakery waste) could be related to the bread source and origin, components, and processing method, therefore, it is recommended to analyze the nutrient content of bread by-product before inclusion in the ruminant diets (Guiroy et al., 2000).

The inclusion of BB in diets of nursing Awassi ewes reduced the cost of diets by 9, 14, and 18% for the BB10, BB15, and BB20 diets, respectively, compared to the BB0 diet. Similar results were obtained by Obeidat et al. (2008) when Awassi lambs fed fattening diets containing *Prosopis Juliflora* pods at levels of 200 g/kg DM. A similar decrease in feed cost was observed in many studies replaced the traditional feedstuffs by alternative and agro-industrial feeds such as bitter vetch (Haddad, 2006), sesame hulls (Obeidat and Aloqaily, 2010; Obeidat and Gharaybeh, 2011), sesame meal (Obeidat et al., 2009), carob pods (Obeidat et al., 2012), broiler litter (Obeidat et al., 2011), and bakery waste (Haddad and Ereifej, 2004; Hindiyeh et al., 2011). The ability of such by-products to share in the ration composition depends mostly on their cost related to the main feedstuff in the ration and nutritive value and chemical composition. Therefore, feeding alternative feeds such as BB would be beneficial and may increase the profit of raising livestock.

Replacement of barley grain by BB had no effect ($p>0.05$) in DM, OM, and CP intake among the experiment diets (Table 2). Similarly, no linear, quadratic and cubic effects were detected in DM, OM, and CP intakes among diets. In agreement to our results, Afzalzadeh et al. (2007) reported no differences in DM intake when fattening Zandi lambs fed diets containing bakery waste at levels of 6, 12.5, and 25% DM compared to control diet. In contrast,

Table 2. Effects of bread by-product on nutrient intake of nursing Awassi ewes

Items	Diets[1]				SE	p-value contrast		
	BB0	BB10	BB15	BB20		Linear	Quadratic	Cubic
Nutrient intake, g/d								
Dry matter	2,319	2,330	2,257	2,258	49.8	0.38	0.51	0.49
Organic matter	2,102	2,112	2,064	2,073	44.3	0.54	0.60	0.56
Crude protein	348	350	342	342	7.6	0.59	0.60	0.60
Neutral detergent fiber	825[a]	772[b]	677[c]	640[c]	17.7	<0.001	0.36	0.22
Acid detergent fiber	425[a]	416[a]	359[b]	342[c]	9.0	<0.001	0.04	0.04

[1] Diets: bread by-product (BB) included in the diets at 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of dietary dry matter.
[a,b,c] Within a row, means without a common letters (a, b, and c) differ ($p<0.05$).

Table 3. Effects of bread by-product on nutrient digestibility of nursing Awassi ewes

Items	Diets[1]				SE	p-value contrast		
	BB0	BB10	BB15	BB20		Linear	Quadratic	Cubic
Digestibility coefficients (%)								
Dry matter	69.1	69.6	72.2	70.6	4.91	0.66	0.86	0.77
Organic matter	72.6	72.4	74.9	75.0	4.12	0.70	0.79	0.78
Crude protein	75.9	75.9	74.8	71.9	4.09	0.86	0.91	0.97
Neutral detergent fiber	56.7	48.2	50.4	49.5	9.84	0.66	0.67	0.76
Acid detergent fiber	49.0	46.9	45.1	40.8	11.44	0.81	0.99	0.96

[1] Diets: bread by-product (BB) included in the diets at 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of dietary dry matter.

Hindiyeh et al. (2011) found that DM, OM, and CP intakes were decreased in Awassi lambs fed diets contained various levels of bakery waste. Similarly, Champe and Church (1980) observed that feed consumption was lower in sheep fed dry bakery product at level of 40% DM than when sheep fed the basal diet. Moreover, Guiroy et al. (2000) observed a reduction in DM intake in feed steers fed a diet contained 55% DM bread by-product. Haddad and Ereifej (2004) also observed that DM, CP, and NDF intakes decreased in goat kids fed BB at level of 30% DM versus kids fed lower levels of BB (0, 10, or 20% DM). It was expected that feeding highly fermentable carbohydrates such as BB may reduce the feed intake and cause acidosis (Morgante, 2002). However, herein there was no reduction in feed intake was observed in all diets. In the current study, no signs of clinical acidosis were observed among ewes in different treatment diets. Therefore, subclinical cases are also unexpected as no differences in intake were identified. It could be speculated that ewes fed on BB diets adapted easily to this kind of diet or the level of BB used in the current study did not exhibit any reduction in feed intake or acidosis.

However, NDF intake was the lowest ($p<0.05$) in ewes fed the BB15 and BB20 diets followed by the BB10 and BB0 diets. Similarly, NDF intake decreased linearly ($p<0.001$) as the BB content increased. Acid detergent fiber intake was reduced as the level the level of BB increased, and average ADF intake was 425, 416, 359, and 342±9.0 g/d for BB0, BB10, BB15, and BB20 diets, respectively. Moreover, a linear ($p<0.001$), quadratic ($p = 0.04$), and cubic ($p = 0.04$) effects were observed in ADF intake among diets. The lower NDF and ADF intakes for the BB diets can be explained by differences in NDF and ADF dietary concentrations (Table 1). It could be concluded that the differences in intakes of bakery waste and/or bread waste included in diets of livestock could be related to the composition of this BB product itself, species, composition of the basal diet, and inclusion level.

In general, digestibility is closely related to the composition of the diets. However, when barley grain was replaced by BB nutrient digestibility was not different among all diets. Similarly, Haddad and Ereifej (2004) found that DM, OM, and NDF digestibility was not affected with increasing levels of BB, i.e., 10, 20, and 30% DM, in goat kids diet. Furthermore, Champe and Church (1980) found that DM and OM digestibility increased when BB was fed to sheep at levels 20 or 40% DM compared to the basal diet while there was a slight increase in CP digestibility in BB diets than the basal diet. However, ADF digestibility was increased ($p<0.05$) in sheep fed BB at level 40% DM whereas no differences were observed among the basal and 20% DM BB diets (Champe and Church, 1980).

Ewes' initial and final body weight and body weights were similar among all diets (Table 4). Similarly,

Table 4. Effects of bread by-product on performance of nursing Awassi ewes and their lambs

Items	Diets[1]				SE	p-value contrast		
	BB0	BB10	BB15	BB20		Linear	Quadratic	Cubic
Ewes								
Initial body weight (kg)	56.5	55.8	56.1	56.1	1.94	0.88	0.83	0.88
Final body weight (kg)	55.0	56.9	55.2	54.8	1.65	0.93	0.39	0.52
Body weight change (kg)[2]	-1.5	+1.1	-0.9	-1.3	1.19	0.72	0.13	0.26
Lambs								
Initial body weight (kg)	9.4	11.3	9.7	9.2	0.92	0.82	0.13	0.27
Weaning body weight (kg)	22.0	24.6	24.8	22.6	1.36	0.15	0.50	0.98
Average daily gain (g/d)	257	270	308	273	21.9	0.10	0.64	0.32

[1] Diets: bread by-product (BB) included in the diets at 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of dietary dry matter.
[2] Body weight change = final body weight-initial body weight.

Table 5. Effects of bread by-product on milk production and composition, feed efficiency, and cost of milk production of nursing Awassi ewes

Items	Diets[1]				SE	p-value contrast		
	BB0	BB10	BB15	BB20		Linear	Quadratic	Cubic
Milk production (g/d)	688	598	649	707	54.2	0.61	0.30	0.59
Milk composition (%)								
Total solids	13.4	13.9	13.1	13.2	0.31	0.44	0.12	0.14
Fat	3.0	2.8	2.8	2.7	0.15	0.35	0.61	0.65
Protein	5.2	5.3	5.1	5.3	0.10	0.59	0.17	0.11
Composition yield (g/d)								
Total solids	92.9	84.7	85.6	94.9	8.85	0.55	0.68	0.99
Fat	20.0	17.6	18.1	19.5	2.39	0.56	0.62	0.85
Protein	35.4	32.1	32.8	37.4	2.86	0.52	0.56	0.97
Feed efficiency (DMI: milk production)	3.65	3.91	3.58	4.04	0.404	0.97	0.04	0.13
Cost/kg of milk production ($US)	1.08[ab]	1.17[a]	0.97[bc]	0.83[c]	0.07	0.14	0.08	0.17

[1] Diets: bread by-product (BB) included in the diets at 0 (BB0), 10 (BB10), 15 (BB15), and 20% (BB20) of dietary dry matter.
[a,b,c] Within a row, means without a common letters (a, b, and c) differ (p<0.05).

performance of lambs (i.e., initial and weaning body weight and average daily gain) was also not affected by the inclusion of BB. These results would be expected as all groups had same levels of nutrient intake and digestibility.

Inclusion of BB in diets of nursing Awassi ewes had no effect (p>0.05) on milk production and composition among treatment diets (Table 5). In agreement, Christodoulou et al. (2005) found that milk yield and composition were not affected when chickpeas was fed to lactating ewes at levels 12 or 24% DM. Overall, results of milk production and composition indicated that partial replacement of barley grain by BB in Awassi ewes lactation diets had no effects on milk production and composition.

No differences (p>0.05) were observed in milk efficiency among all diets (Table 5). However, a quadratic (p = 0.04) effect was noted among diets. However, the cost of milk production was the least (p<0.05) for ewes fed BB15 and BB20. The reduction of milk cost is reported in other study as well (Obeidat et al., 2012) when barley grain was replaced partially by carob pods at levels 20 or 40% in Awassi ewes fed lactation diets. The reduction in the cost of milk production is closely related to the diets cost. As discussed previously the inclusion of the BB reduced the diets cost when compared to the free BB containing diet. Therefore, any reduction in the cost of milk production would be beneficial for milk producers.

CONCLUSION

In spite the similarity in the performance of ewes (i.e., nutrient intake and digestibility, body weight changes, and milk production and composition), feeding different levels of bread by-product could be used as alternative feedstuff to replace the barley grain in sheep feeding. Cost of milk production was reduced mainly in the group that fed on BB20 diet. However, more research is needed to study the effect of feeding ewes greater levels of bread by-product on performance of nursing Awassi ewes.

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