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Substituting Bakery Waste for Barley Grains in Fattening Diets for Awassi Lambs

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ABSTRACT : Bakery waste (BW) is much cheaper than barley (20 to 40% the price of barley). Bakery waste and barley grain have similar chemical composition; they contain 99 and 97% organic matter (OM), 1.1 and 1.8% fat, 18 and 15% neutral detergent fibre (NDF) and 14.0 and 14.5% crude protein (CP), respectively (DM basis). The objectives of this study were to determine the effect of substituting BW for barley grain in high concentrate fattening diets for lambs on nutrient intake, growth and carcass characteristics. Forty Awassi lambs (21.75±1 kg) weaned at the age of 65 days were assigned randomly to four experimental fattening diets differing in BW ratio in a completely randomized design. The control diet (CON) contained 20, 60, 11, 7, and 2% (DM basis) wheat straw, barley grain, soybean meal, corn grain, and minerals and vitamin mix, respectively. Bakery waste substituted barley grain by 10, 20 and 30% of the diet DM in the LBW, MBW and HBW diets, respectively. The experiment lasted for 56 days. Dry matter intake (DMI) decreased ($p<0.05$) in LBW diet compared to the CON diet by approximately 10%. No further reduction in DMI was observed with the higher substitution levels. Metabolizable energy intake for the CON diet (3.6 Mcal/d) was also reduced ($p<0.05$) compared with LBW, MBW and HBW diets (3.4, 3.4 and 3.3 Mcal/d, respectively). Final body weight for lambs fed the CON diet (34.8 kg) was higher ($p<0.05$) compared with lambs fed the LBW, MBW and HBW diets (30.6, 32.0 and 31.1 kg, respectively). Growth rate for lambs fed the CON diet (232 g/d) was also higher ($p<0.05$) compared to lambs fed the LBW, MBW and HBW diets (170, 189, and 167 g/d, respectively). Feed to gain ratio was higher ($p<0.05$) for lambs fed the LBW, MBW and HBW diets (7.2, 6.6 and 7.3, respectively) compared with lambs that consumed the CON diet (5.7). Body weight gain cost was reduced by approximately 8% by the MBW and HBW diets as compared with the CON diet. Dressing percentage, full gut weight, empty gut weight and liver weights were all unaffected by the BW addition to the diets and averaged 48.9%, 6.8 kg, 2.8 kg and 0.444 kg, respectively. However, fat tail weight was increased ($p<0.05$) with the higher levels of the BW inclusion. In conclusion, substituting BW for barley grain reduced DMI and growth performance. However, when BW substituted barley grain at the 20 and 30% of the diet DM, body weight gain cost was reduced by approximately 8%. (**Key Words :** Bakery Waste, Barley Grain, Fattening, Awassi)

INTRODUCTION

Awassi is the dominant sheep breed in Middle East and it is the only indigenous breed in Jordan (Zarkawi, 1997). Awassi is a multi-purpose breed raised for meat, milk and wool production and its well known for its adaptation to harsh, semi-arid environments and its resistance to diseases (Al-Jassim et al., 1999).

In Jordan, 80% of the production cost of red meat from fattening Awassi lambs is attributed to feed cost (Harb and Habbab, 1989). Barley grain is the predominant grain source for fattening lambs and kids throughout the Middle East area (Haddad et al., 2001). Grain based commercial supplements and diets for fattening small ruminant are not economical in most cases (Nör and Ströbel, 1996).

Bakery Waste (BW) consists of surplus and left over materials collected from bakeries and other food processing plants. It is sold to farmers at reasonable prices (20 to 40% of barley grain price). Bakery waste and barley grain have similar chemical composition; they contain 99 and 97% organic matter (OM), 1.1 and 1.8% fat, 18 and 15% neutral detergent fibre (NDF) and 14.0 and 14.5% crude protein (CP), respectively (DM basis). Therefore, substituting BW for barley grain in fattening diets would be of economical importance. Haddad and Ereifej (2004) concluded that substituting BW for barley grain up to 20% of the diet DM

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did not affect nutrient intake and digestibility of kids and resulted in a decrease in feed cost. Moreover, BW substituted up to 75% of whole shelled corn in a growing-finishing beef feedlot diet without reducing meat quality or feedlot performance (Guiroy et al., 2000). The objectives of this study were to determine the effects of substitution BW for barley grain in high concentration fattening diets for lamb on nutrient intake, growth and slaughtering characteristics.

MATERIALS AND METHODS

This experiment was conducted at the Agriculture Center for Research and Production at the Jordan University of Science and Technology. Forty Awassi lambs (21.75±1 kg) weaned at the age of 65 days were housed in individual pens (1.5×0.75 m). Lambs were then assigned randomly to four experimental fattening diets (10 lambs/diet) differing in BW ratio in a completely randomized design and were adapted to their experimental diets for one week. The control diet contained 20, 60, 11, 7, and 2% (DM basis) wheat straw, barley grain, soybean meal, corn grain, and minerals and vitamin mix, respectively. Bakery Waste substitute barley grain by 10, 20, and 30% of the diet DM in the LBW, MBW, and HBW diets, respectively, as shown in Table 1.

The BW was obtained from the Jordan University of Science and Technology bakery over several weeks. It was air dried for 20 days, ground, and stored until the beginning of the experiment.

The experimental period lasted for 56 days. Diets were fed as totally mixed rations once daily at 9:00 h in amounts to insure 10% orts. The amount of feed offered and refused for each lamb was recorded daily. Clean drinking water was available in plastic buckets and animal pens were cleaned weekly. Lamb weights were recorded weekly before feeding to monitor body weight change throughout the experiment. Experimental diets were mixed biweekly and were sampled upon mixing to insure proper mixing. All vitamins and minerals were added to the experimental diets to meet or exceed the requirements (National Research Council, 1985).

Samples of individual ingredient and diet were analyzed for CP (AOAC, 1990), dry matter (DM) by oven drying for 48 h at 96°C, ash by combustion at 550°C for 6 h, acid detergent fiber (ADF) analyzed by the procedure of Goering and Van Soest (1970), and α-modified NDF by the procedure of Van Soest et al. (1991). Metabolizable energy content was calculated using tabular values (National Research Council, 1985).

At the end of the experiment, 6 lambs from each treatment were randomly selected and slaughtered after 15-h fast. The heads and feet were removed from the bodies. The carcass was eviscerated and the hot carcass weight was determined. The livers were weighed and the gastrointestinal (GI) tract was weighed with its content and after being emptied for the determination of the GI content weight. Cold carcass weight was determined after chilling for 24 h at 4°C. Fat tail was removed after chilling and weighed for each animal. The cold carcass weights and live weights were used for the determination of the dressing percentage.

Data analysis

Data were subjected to ANOVA for a complete randomized design using the general linear procedure of SAS (1991). Differences among treatment means for significant dietary effect on growth and carcass parameters were analyzed using the LSD procedure of SAS. Average daily gain was calculated using the initial weight obtained after the adaptation period and the final weight.

RESULTS AND DISCUSSION

Feed (diet) cost decreased approximately $23/ton for each 10% increase in BW in the experimental diets as

Table 1. Formulation of the experimental diets fed to fattening Awassi lambs

Item	Diet*			
	CON	LBW	MBW	HBW
% of DM				
Wheat straw, chopped	20	20	20	20
Barley grains	60	50	40	30
Bakery waste	0	10	20	30
Corn grains	7	7	7	7
Soybean meal	11	11	11	11
Salt	0.99	0.99	0.99	0.99
Limestone	1	1	1	1
Minerals and vitamins*	0.01	0.01	0.01	0.01
Cost ($/ton)	224	201	178	155

* Contained (vitamin A, 450,000 IU; vitamin D_3, 11,000,000 IU; vitamin E, 3.18 g, Mn, 10.9 g; Zn, 22.73 g; Fe, 22.73 g; Cu, 2.73 g; Co, 0.635 g; Mg, 100 g; Se, 0.1 g) per 1,000 g.

Table 2. Chemical composition of the experimental diets

Item	Diets			
	CON	LBW	MBW	HBW
Dry matter (%)	92.7	93.0	93.3	93.5
Organic matter (% of DM)	93.2	94.0	93.5	93.7
Crude protein (% of DM)	15.7	15.7	15.7	15.7
Neutral detergent fiber (% of DM)	28.7	28.0	27.8	27.9
Acid detergent fiber (% of DM)	15	15	14	14
Metabolizable energy[1] (Mcal/kg)	2.76	2.75	2.74	2.73

[1] Calculated using NRC (1985).

compared to the CON diet as shown in Table 1. Bakery Waste replaced barley grains by 0, 10, 20, and 30% of the diet DM. The similar chemical composition of BW and barley resulted in similar OM and CP contents among all diets and averaged 93.6, 15.7 and 28.2% for OM, CP and NDF, respectively (Table 2).

Dry matter intake (DMI) for the CON diet (1,320 g/d) decreased ($p<0.05$) by approximately 10% compared with the LBW diet (Table 3). No further reduction in DMI was observed with the higher substitution levels (MBW and HBW diets). This 10% reduction in DMI between the CON diet and the BW diets was reflected on intake of OM, CP and NDF as shown in Table 3. Moreover, lambs fed the BW diets showed much higher daily DMI fluctuation compared with lambs fed the CON diets. Metabolizable energy intake for the CON diet (3.6 Mcal/d) was also reduced ($p<0.05$) compared with LBW, MBW and HBW diets (3.4, 3.4 and 3.3 Mcal/d, respectively).

The reduction in DMI was reflected on final weight and growth rate of lambs fed the experimental diets (Table 4). Final body weight for lambs fed the CON diet (34.8 kg) was higher ($p<0.05$) compared with lambs fed the LBW, MBW and HBW diets (30.6, 32.0 and 31.1 kg, respectively). On average, lambs fed the CON diets gained 24% more weight than lambs fed diets containing BW. Growth rate for lambs fed the CON diet (232 g/d) was also higher ($p<0.05$) compared to lambs fed the LBW, MBW and HBW diets (170, 189, and 167 g/d, respectively). Feed to gain ratio was higher ($p<0.05$) for lambs fed the LBW, MBW and HBW diets (7.2, 6.6 and 7.3, respectively) compared with lambs that consumed the CON diet (5.7). Body weight gain cost was reduced by approximately 8% by the MBW and HBW diets as compared with the CON diet as shown in Table 4.

Slaughtering characteristics were not affected ($p>0.05$) by the addition of BW to the diets as shown in Table 5. Dressing percentage, full, and empty gut weight and liver

Table 3. Nutrient intake of Awassi lambs fed the experimental diets

Item	Diets				
	CON	LBW	MBW	HBW	SE
Intake (g/d)					
Dry matter	1,320 [a]	1,232 [b]	1,247 [b]	1,223 [b]	42
Organic matter	1,223 [a]	1,158 [b]	1,166 [b]	1,145 [b]	33
Crude protein	207 [a]	193 [b]	195 [b]	192 [b]	5
Neutral detergent fiber	378 [a]	344 [b]	346 [b]	341 [b]	7
Metabolizable energy (Mcal/d)	3.6 [a]	3.4 [b]	3.4 [b]	3.3 [b]	0.1

[a, b] Means in a row with different letters differ ($p<0.05$).

Table 4. Production responses of Awassi lambs fed the experimental diets

Item	Diet				
	CON	LBW	MBW	HBW	SE
Initial body weight (kg)	21.8	22.1	21.4	21.7	1.0
Final body weight (kg)	34.8 [a]	30.6 [b]	32.0 [b]	31.1 [b]	1.1
Weight gain (kg)	13.0 [a]	9.5 [b]	10.6 [b]	9.4 [b]	1.4
Average daily gain (g/d)	232 [a]	170 [b]	189 [b]	167 [b]	25
Feed to gain	5.7 [a]	7.2 [b]	6.6 [b]	7.3 [b]	1.1
Cost ($/kg gain)	1.28	1.43	1.18	1.13	

[a, b] Means in a row with different letters differ ($p<0.05$).

Table 5. Effect of experimental diets on slaughtering and carcass characteristics of Awassi lambs

Item	Diets				
	CON	LBW	MBW	HBW	SE
Dressing (%)	49.0	50.6	50.5	46.1	2.5
Full GI tract weight (kg)	7.0	6.4	7.0	7.1	1.2
Empty GI tract weight (kg)	3.0	2.7	3.0	2.9	0.85
Liver weight (kg)	0.460	0.393	0.464	0.457	0.1
Fat tail (kg)	1.4 [b]	1.5 [b]	2.3 [a]	1.7 [a]	0.1

[a,b] Means in a row with different letters differ ($p<0.05$).

weights were all unaffected by the BW addition to the diets and averaged 48.9%, 6.8 kg, 2.8 kg and 0.444 kg, respectively. However, lambs fed the MBW and HBW diets had heavier ($p<0.05$) fat tails compared to lambs fed the CON and LBW diets (Table 5).

The results of this experiment are in consistence with Nelson et al. (2000) who substituted barley grain with potato by-product which had similar chemical composition to BW and observed a reduction in DM intake of steers when the potato by-product was above 10% of the diet DM. This reduction in DM intake was accompanied by a reduction in steer performance.

In contrast, Guiroy et al. (2000) conducted an experiment to study the effects of substituting BW with whole corn and concluded that BW can substitute corn up to 75% of the diet DM for growing finishing steers without any reduction in performance. Similar results were also reported by Haddad and Ereifej (2004) who replaced BW for barley grain for fattening kids and concluded that substitution of barley grain with up to 20% of the diet DM had no effect on intake and performance.

A large portion of the variation observed with the very limited published data for BW could be attributed to the considerable variation in composition of the various BW studied. Arosemena et al. (1995) reported considerable differences in BW composition from the corresponding values previously reported in the literature (NRC, 1989). Furthermore, Milton and Brandt (1994) suggested an optimal level of inclusion of bakery waste below 30% of the diet DM, while Huber (1981) recommended no more than 10% in the feedlot diets.

Another source of variation could be attributed to the fermentability of the different BW products. The BW used in this study was 80% wheat flour which is highly fermentable and may have caused subacute acidosis which may explain the daily DMI fluctuation observed for lambs fed the diets containing the BW.

The reduction in growth performance observed with the diets that contained BW in the current study could be attributed to two reasons: first is the reduction of DMI which decreased the net energy available for production and resulted in 24% reduction in growth performance; and to the large fluctuation in DMI observed for lambs fed the BW diets.

Intake fluctuation had negative relationship with performance. However, this does not necessarily suggest that intake fluctuation decreased performance directly, but that intake fluctuation is a sign of subacute acidosis which decrease performance (Britton and Stock, 1987; Cooper et al., 1999).

CONCLUSION

Substituting BW for barley grain reduced DMI and growth performance. However, when BW substituted barley grain in the 20 and 30% of the diet DM, body weight gain cost was reduced by approximately 8%.

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