PAPER

Effects of replacing soybean meal with xylose-treated soybean meal on performance of nursing Awassi ewes and fattening lambs

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Abstract

Two experiments were conducted to evaluate the effect of replacing soybean meal with xylose-treated soybean meal (soypass meal; SPM) on performance of nursing Awassi ewes and fattening lambs. In Experiment 1, lasting for eight weeks, 39 Awassi ewes and their lambs were randomly assigned to three diets. Diets were formulated by replacing soybean meal from the basal diet (CON-SBM; n=13) with 50% (50% SPM; n=13) and 100% (100% SPM; n=13) SPM. Initial and final weights of the ewes were not different (P>0.55) among diets. Total gain and average daily gain (ADG) of lambs were similar (P=0.44) among diets. Ewes fed the CON-SBM diet tended (P<0.09) to have lower milk yields than those fed the 50% SPM and 100% SPM diets. No differences (P>0.38) in milk component percentages among diets were observed. In Experiment 2, lasting for 63 days, twenty weaned lambs were used to determine the effects of replacing soybean meal with SPM on growth performance. Diets were either soybean meal (SBM; n=10) or SPM (SPM; n=10). Nutrient intake and digestibility were not different between diets. However, rumen undegradable protein intake was greater (P<0.05) for the SPM diet than for the SBM diet. Final body weight, ADG and the feed conversion ratio were similar (P>0.05) between the diets. Results suggest that replacement of soybean meal with soypass meal is not likely to produce any production benefits in nursing Awassi ewes and fattening lambs except for the slight improvement of milk yield.

Introduction

Protein sources, either as degradable or undegradable, have been common feed sources used worldwide to improve animal performance by optimising protein intake. Such practice has been implemented in livestock to increase the protein density in lactation diets (Nakamura *et al*., 1992). Because of good palatability, amino acid balance and high availability of soybean meal, it serves as the worldwide standard with regard to protein meals for livestock production. However, soybean meal has low protein efficiency owing to extensive ruminal degradation (NRC, 1985). Therefore, in most research studies of the effects of high rumen undegradable protein supplements, soybean meal was replaced by large amounts of rumen undegradable protein as a supplement, and has been used as the control treatment (Santos *et al*., 1998). The supply of metabolisable protein to the small intestine is derived from microbial protein synthesised in the rumen and rumen undegradable protein from the diet that escapes microbial degradation (NRC, 1985, 1996). Rumen degradable protein requirements in livestock diets have been shown to be met by the use of soybean meal (Nakamura *et al*., 1992), resulting in increases of microbial protein and the supply of protein to the small intestine. However, this source of protein may not meet the requirements of nursing ewes and fattening lambs (Clark *et al*., 1992). Therefore, rumen undegradable protein sources are generally supplemented to increase the non-microbial protein flow to the small intestine (Ipharraquerre and Clark, 2005).

Soypass meal is a supplemental protein produced through non-enzymatic browning (Maillard reaction) of soybean meal to increase the proportion of ruminally undegradable protein (Tuncer and Sacakli, 2003) and, therefore, increase the metabolisable protein supply to the small intestine. Cleale *et al*. (1987) stated that non-enzymatic browning, by reacting soybean meal with xylose in the presence of heat, increased the flow of undegradable protein to the small intestine and improved bypass activity of protein. The estimated ruminal undegradable protein in soypass meal is 61%, as evaluated by Dawson *et al*. (1999). In a study that investigated the effect of replacing soybean meal with fishmeal (which provides high levels of escape protein) in diets of high-producing dairy cattle, Broderick (1992) found that milk production increased in cows that have received fishmeal when compared to the soybean meal group.

Few data are available in evaluating the effect of replacing soybean meal by xylose-treated soybean meal (soypass meal; SPM) on ewes' performance and productivity during the first period of lactation and on growth performance of fattening lambs. Therefore, the objectives of this research were to study the effect of replacing soybean meal with SPM on feed intake, body weight change, milk production and composition of nursing Awassi ewes, and growth rate of their lambs from birth to weaning; additionally, to study its effects on the performance of fattening Awassi lambs.

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Materials and methods

Two experiments were conducted at the Agriculture Center for Research and Production at Jordan University of Science and Technology.

Experiment 1. Awassi ewes nursing single lambs

Animals, diets and design

Thirty-nine Awassi ewes (average body weight: BW=47±1.59 kg, average age=4.5±1.2 yr) nursing single lambs and their lambs were randomly assigned to three treatment diets (13 ewes/treatment diet). Diets (Table 1) were formulated by replacing soybean meal from the basal diet (CON-SBM; n=13) with 50% (50% SPM; n=13) and 100% (100% SPM; n=13) soypass meal as a source of the supplemental protein. Concentrates were mixed every two to three weeks and were sampled for laboratory analysis to ensure consistency in their chemical composition. The 39 ewes were selected from 100 ewes that were synchronised for parturition using intravaginal medroxyprogesterone acetate sponges (60 mg; Vetamix Upjohn Co.) for a period of 14 days. All ewes gave birth within five days of each other.

Animals were adapted to the pens and to the experimental diets for seven days. After adaptation, ewes and their lambs were fed their assigned diets for the following seven weeks. Animals were weighed weekly before the morning feeding throughout the study. Each ewe's BW change was measured by subtracting the initial BW from the final BW. Additionally, average daily gain (ADG) for the lambs was measured by subtracting the initial BW from the final BW and dividing by the duration of the experiment.

Ewes were offered a concentrate mixture (1.2 kg/head/day, as the feed basis) and wheat hay (1.0 kg/head/day, as the feed basis) with free access to fresh water for the duration of the experiment (Table 1). Diets were formulated to be isonitrogenous/isocaloric and to meet the NRC (1985) requirements for nursing ewes. Ewes with their lambs were housed in individual pens (1.5×0.75 m) and subjected to the same practical management during the entire experiment. Feed was offered once per day at 08h00 for all animals. Metabolisable energy was estimated based on tabular values presented in NRC (1985).

According to procedures of AOAC (1990), feed samples were analysed for dry matter (DM) (100°C in a forced-air oven for 24 h), organic matter (OM) (100 - ash percentage; 550°C in a muffle furnace for 8 h), and crude protein (CP) (Kjeldahl procedure; AOAC, 1990). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analysed according to procedures described by Van Soest *et al*. (1991) with modifications for use in the ANKOM^{200} fibre analyser apparatus (ANKOM Technology Cooperation, Fairport, NY). Neutral detergent fibre analyses were conducted using sodium sulphite and alpha amylase (heat stable) and expressed with residual ash content.

Milk production and chemical composition

Milk production measurement was initiated after the adaptation period, approximately during the second week of lactation. For all ewes, milk production over a period of 12 h was estimated weekly throughout the study at 08h00 using hand milking. Lambs were separated from their dams 12 h before milking (Awawdeh *et al*., 2009). Milk yield was calculated over the 24-hour period (Fadel *et al*., 1989). For chemical composition of milk, five ewes from each treatment were randomly chosen and a 125-ml sample was collected from each ewe and analysed immediately for total solids (TS), fat, protein and ash. The same ewes were sampled for chemical analysis throughout the experiment. Total solids were evaluated using an air-force oven at 50°C to reach a constant weight, then at 100°C for 24 hrs (AOAC, 1990). Crude protein was evaluated using the Kjeldahl procedure. Fat content was analysed according to the Gerber procedure.

Statistical methods

All data analyses were conducted using the Proc Mixed procedure of SAS (Version 8.1, 2000, SAS Inst., Inc., Cary, NC, USA) and a completely randomised design. Milk production and composition, and ewe and lamb body weights were analysed using repeated measures with a model that included treatment, week and treatment × week interaction. Initial milk production and initial body weight for lambs were used as a covariant for analysis for milk production and average daily gain, respectively. Ewe and lambs were considered to be a random effect. The appropriate covariance structure of the data was chosen for each analysis from the structure of compound symmetric, autoregressive order one, and unstructured. Additionally, the main effect was tested for linear and quadratic effect. Means were separated using the PDIFF function associated with the generation of least squares means.

Experiment 2. Fattening Awassi lambs fed finishing diets

Experimental design, animals and diets

Twenty-weaned Awassi ram lambs (average BW=20.4±0.93 kg) were housed in individual pens (0.75×1.5 m). Lambs were weighed at the beginning of the study and then stratified by weight and randomly assigned to one of two treatment diets. Diets were formulated by replacing soybean meal from the basal diet (SBM; n=10) with soypass meal (SPM; n=10) as a source of the supplemental protein. Diets were isonitrogenous/isocaloric and formulated to have 16% CP (Table 2) and to meet nutrient requirements (NRC, 1985) and offered to the lambs as total mixed rations. On mixing, diets were sampled for laboratory analysis to ensure proper mixing. The basal diet consisted of barley grain (62%), soybean meal (15%), wheat hay (20%), salt (1.4%), limestone (1.5%) and minerals and vitamins (0.1%). The composition per 1000 g of the minerals and vitamins mix contained dicalcium phosphate, 800 g; sodium chloride, 60 g; trace elements mixture (Zn, Mn, Fe, Cu, Co, Se), 20 g; magnesium oxide, 20 g; vitamin A, 500,000 U; vitamin D3, 85,000 U, vitamin E, 200 U. The SPM diet contained the same ingredients as in the SBM diet except for the SBM being replaced by SPM.

Lambs were given an adaptation period of

Table 1. Ingredients and nutrient composition of the concentrate mixture fed to nursing ewes (Experiment 1).

Item	Diets[A]		
	CON-SBM	50% SPM	100% SPM
Ingredients, %			
Barley grain	55.0	55.0	55.0
Corn grain	14.0	14.0	14.0
Soybean meal	15.0	7.5	0
Soypass meal	0	7.5	15.0
Wheat bran	13.0	13.0	13.0
Salt	1.5	1.5	1.5
Limestone	1.4	1.4	1.4
Minerals and vitamins[B]	0.1	0.1	0.1
Nutrients			
Dry matter, %	89.6	90.0	90.6
Organic matter, % DM	90.1	91.4	90.9
Crude protein, % DM	17.2	17.0	17.2
Neutral detergent fibre, % DM	21.9	21.5	21.1
Acid detergent fibre, % DM	14.2	14.1	13.5
Rumen undegradable protein, % CP[C]	39.0	45.9	52.9
Metabolisable energy, Mcal/kg[D]	2.60	2.61	2.62

[A]Diets were formulated by replacing soybean meal from the basal diet (CON-SBM; n=13) with 50% (50% SPM; n=13) and 100% (100% SPM; n=13) of soypass meal as a source of the supplemental protein. [B]Composition per 1 kg contained dicalcium phosphate, 800 g; sodium chloride, 60 g; trace elements (Zn, Mn, Fe, Cu, Co, Se) mixture, 20 g; magnesium oxide, 20 g; vitamin A, 500,000 U; vitamin D3, 85,000 U; vitamin E, 200 U. [C]Rumen undegradable protein estimated from NRC (2001). [D]Metabolisable energy estimated from NRC (1985) tabular values.

seven days before the intensive feeding trial that lasted for 63 days. Lambs were individually weighed (to the nearest 0.250 kg) before feeding the assigned diets on two consecutive days to determine the initial weight. Lambs were weighed every seven days before the morning feeding to minimise variation owing to feeding, drinking and defaecation. Lambs were fed *ad libitum* twice per day at 08h00 and 16h00 with free access to fresh water. Feed refusals were collected, weighed and sampled for future analyses. Dry matter and other nutrient intakes, ADG and the feed conversion ratio were calculated during the finishing trial.

At the end of the finishing period, three animals from each treatment group were randomly chosen and individually housed in metabolism crates that allowed for faecal and urine separation to evaluate nutrient digestibilities and nitrogen balance. Animals were given seven days as an adaptation period for the metabolism crates followed by a four-day collection period. Diets similar to those used in the finishing trial were offered to lambs during the metabolism period of *ad libitum* consumption at 08h00, with free access to fresh water. During the four-day collection period, feed intake and refusals were recorded daily. Daily faecal output was collected, weighed, mixed, sampled (10%) and saved (-20°C) for future analyses. Using plastic containers containing 50 mL of 6N HCl to prevent ammonia loss, urine was collected, weighed, mixed, sampled (5%) and saved (-20°C) to determine urinary nitrogen excretion. All samples were composited for each lamb at the end of the collection period. Samples of feed, refusals and faeces were dried (at 55°C in a forced-air oven to reach a constant weight, air equilibrated), and ground to pass through a 1 mm screen (Brabender Ohg, Duisburg, type 880845, Nr 958084, Germany) and saved for future analysis.

Following to the procedures of AOAC (1990), feed and faecal samples were analysed for DM, OM and CP as described previously, and NDF and ADF were analysed as before. Urine samples were analysed for nitrogen (Kjeldahl procedure) to evaluate the nitrogen balance.

Statistical methods

All data were analysed using the Mixed procedure of SAS (version 8.1, 2000, SAS Inst. Inc., Cary, NC, USA). The model used treatment as the only fixed effect. Initial body weight was used as a covariant for analysis of ADG. Least square means were separated using appropriate pair-wise t-tests if the fixed effects were significant (P<0.05).

Results

Experiment 1. Awassi ewes nursing single lambs

Results of the performance of ewes and their lambs are presented in Table 3. There were no feed refusals during the trial, thus intake of the concentrate mixture and wheat hay were identical for dietary treatments and were, as offered, 1.2 and 1.0 kg/head/day, respectively. Thus, intake data were not statistically analysed.

Initial and final weights of ewes were not different (P=0.55) among treatment diets. As a result, BW changes of ewes did not differ (P=0.54) and all treatment diets had small weight changes during the trial. In addition, total gain and ADG of lambs were similar (P=0.44) among treatment diets.

No week × treatment interaction existed (P>0.05) for milk yield and milk components; therefore, only main effects are presented in Table 4. Interestingly, a linear increase (P=0.05) was noted for the milk production between treatments. However, quadratic effect (P=0.35) was not detected for milk production between treatment diets. Ewes fed the CON-SBM diet tended (P<0.09) to have lower milk yields than those fed the 50% SPM and 100% SPM diets. No differences (P>0.38) in all milk component percentages among treatment diets were observed during the course of the study. Additionally, there were no linear (P≥0.21) or quadratic (P≥0.39) differences between treatment diets for the milk components.

Experiment 2. Fattening Awassi lambs fed finishing diets

Results of DM, OM, CP, NDF and ADF intakes are presented in Table 5. Intakes of DM, OM, CP, NDF and ADF were similar (P>0.42) for lambs fed the SBM and SPM diets. However, intake of rumen undegradable protein (RUP) was greater (P<0.05) in lambs

Table 2. Chemical composition of the experimental diets (Experiment 2).

Item	Diets[A]	
	SBM	SPM
Nutrients		
Dry matter, %	89.9	90.2
Organic matter, % DM	89.5	87.7
Crude protein, % DM	15.9	16.0
Neutral detergent fibre, % DM	37.5	35.7
Acid detergent fibre, % DM	20.4	18.9
Rumen undegradable protein[B], % CP	35.2	50.9
Metabolisable energy[C], Mcal/kg	2.7	2.7

[A]Diets were soybean meal (SBM; n=10) and soypass meal (SPM; n=10). [B]Rumen undegradable protein estimated from NRC (2001). [C]Metabolisable energy estimated from NRC (1985) tabular values.

Table 3. Effects of replacing soybean meal with soypass meal on performance of nursing ewes and their lambs (Experiment 1).

Item	Diets[A]			SEM	P
	CON-SBM	50% SPM	100% SPM		
Ewes					
Intake					
Concentrate, kg/head/d	1.2	1.2	1.2	-	-
Wheat hay, kg/head/d	1.0	1.0	1.0	-	-
Initial weight, kg	47.9	45.6	47.5	1.59	0.55
Final weight, kg	47.0	46.2	46.9	1.60	0.92
Body weight change[B], kg/d	-0.9	+0.6	-0.7	0.99	0.54
Lambs					
Initial weight, kg/d	7.3	7.2	7.8	0.28	0.29
Weaning weight, kg/d	19.1	19.8	20.9	0.70	0.22
Total gain, kg	11.8	12.6	13.0	0.68	0.44
Average daily gain, g/d	210.9	224.6	232.8	12.06	0.44

[A]Diets were formulated by replacing soybean meal from the basal diet (CON-SBM; n=13) with 50% (50% SPM; n=13) and 100% (100% SPM; n=13) of soypass meal as a source of the supplemental protein. [B]Body weight change of ewes = final weight – initial weight.

fed the SPM treatment diet than in lambs fed the SBM treatment diet (55.9 vs 39.6 g/d).

Mean values of the initial BW, final BW, total gain, ADG and feed conversion ratio are presented in Table 5. At the beginning of the experiment, the initial BW of lambs was similar (P=0.97) between the two diets. Final BW, total gain, ADG and feed conversion ratio were similar (P>0.30) between the diets.

Least square means of digestibility of DM, OM, CP, NDF, ADF and nitrogen balance are presented in Table 6. No differences (P>0.05) were observed in DM, OM, CP, NDF and ADF digestibilities among diets. Nitrogen intake and faecal and urinary nitrogen excretions were similar (P>0.05) among diets. A positive nitrogen balance was observed for both diets. In addition, retained nitrogen (g/d) was not different between the two diets. Numerical differences in nitrogen balance data were detected between treatment diets. Unfortunately, no significant differences were detected between treatment diets perhaps in part because of the huge variations in nutrient digestibility and nitrogen balance data within each group.

Discussion

Experiment 1. Awassi ewes nursing single lambs

Owing to its palatability and good amino acid balance (i.e. lysine and histidine; Santos *et al*., 1998), soybean meal is the most commonly used protein supplement in livestock diets. However, soybean meal has relatively low protein efficiency because of extensive ruminal degradation and it is estimated that approximately two thirds of protein in soybean meal are degraded in the rumen (NRC, 2001). Therefore, reducing ruminal degradability would improve animals' performance. In the current study, soypass meal (xylose-treated-SBM) is used to replace the soybean meal in diets of nursing ewes during the first phase of lactation and of their growing lambs. All ewes had similar BW change throughout the study, indicating that the assigned diets were enough to meet the nutrient requirements during the nursing period. In addition, the type of the protein sources did not affect growth rate of lambs during the pre-weaning period.

Results of the effect of increasing the RUP supply, by replacing solvent SBM with protected sources, on the performance of Awassi ewes is scarce. In dairy cows, results have been inconsistent. Santos *et al*. (1998) reviewed published data for dairy cows from 1985 to

Table 4. Effects of replacing soybean meal with soypass meal on milk yield and composition in nursing Awassi ewes (Experiment 1).

Item	Diets[A]			SEM	P[B]		
	CON-SBM	50% SPM	100% SPM		1	2	3
Milk yield, g/d	473.7	555.4	562.5	32.73	<0.09	=0.05	0.35
Milk composition, g/kg							
Total solids	140	138	140	4.4	0.93	0.96	0.72
Fat	32	34	33	2.8	0.99	0.89	0.39
Protein	45	44	46	1.5	0.59	0.60	0.39
Ash	9.2	11.0	11.4	1.2	0.38	0.21	0.60

[A]Diets were formulated by replacing soybean meal from the basal diet (CON-SBM; n=13) with 50% (50% SPM; n=13) and 100% (100% SPM; n=13). [B]1=Probability for the main effect of feeding SPM. 2=Probability for the linear effect of feeding SPM. 3=Probability for the quadratic effect of feeding SPM.

Table 5. Nutrient intake and growth performance of Awassi ram lambs fed concentrate diets containing soybean meal or soypass meal (Experiment 2).

Item	Diets[A]		SEM	P
	SBM	SPM		
Nutrient intake, g/d				
Dry matter	737	777	34.7	0.42
Organic matter	669	699	31.1	0.50
Crude protein	112	110	6.5	0.89
Neutral detergent fibre	276	273	12.1	0.85
Acid detergent fibre	151	151	6.4	0.96
Rumen undegradable protein[B]	39.6	55.9	2.75	<0.05
Initial body weight, kg	20.4	20.4	0.93	0.97
Final body weight, kg	37.4	38.7	1.52	0.55
Total gain, kg	17.0	18.3	0.90	0.34
Average daily gain, g/d	269.8	289.7	14.23	0.34
Feed conversion ratio, kg/kg	2.76	2.69	0.08	0.56

[A]Diets were soybean meal (SBM; n=10) or soypass meal (SPM; n=10). [B]Rumen undegradable protein estimated from NRC (2001).

Table 6. Nutrient digestibilities and N balance of Awassi ram lambs fed concentrate diets containing soybean meal or soypass meal (Experiment 2).

Item	Diets[A]		SEM	P
	SBM	SPM		
Dry matter intake, g/d	1528	1193	123.3	0.13
Digestibility, %				
Dry matter	68.2	74.6	5.63	0.47
Organic matter	69.3	75.0	5.53	0.50
Crude protein	67.8	69.0	6.12	0.90
Neutral detergent fibre	47.2	46.6	7.13	0.95
Acid detergent fibre	53.6	52.0	6.04	0.86
Nitrogen, g/d				
Intake	38.1	28.2	3.58	0.12
Faecal	12.4	9.4	2.80	0.49
Urinary	12.9	14.4	2.99	0.74
Retained	12.7	4.5	8.50	0.15

[A]Diets were soybean meal (SBM; n=10) or soypass meal (SPM; n=10).

1997 and reported that in most cases replacing SBM with protected SBM did not improve milk yield. As compared to unprotected SBM, protected SBM increased milk yield in only six out of 29 comparisons. Santos *et al*. (1998) attributed the lack of response to increased RUP supply mainly to reduced microbial protein, low intestinal digestibility of RUP, inferior profile of EAA in RUP, and/or the control diets already containing enough RUP. Similarly, Ipharraguene and Clark (2005) reviewed a data base of trials regarding the effect of replacing untreated SBM with treated SBM on the performance of dairy cows. The authors reported that the response was dependent on the CP content of the control diet and there was only a slight increase in milk yield (average of <3% increase).

Daily milk yield improved slightly when ewes consumed the SPM diets as compared to the CON-SBM, with no differences being detected in milk composition among treatment diets. Results of milk yield are consistent with the findings of Annexstad *et al*. (1990), who replaced soybean meal with lignosuphonate-treated SBM in diets of lactating dairy cows and found that milk yield increased as compared to that in those receiving soybean meal. Titgemeyer and Shirley (1997) concluded that feeding Soy Best for dairy cows versus unheated SBM in 18.5% CP diets revealed a positive lactation response through increasing milk production. Similarly, Shirley *et al*. (1997) reported greater milk production for early lactation cows fed a Soy Best diet that contained 16% CP (40% RUP) compared to lower milk production for cows fed unheated SBM or animal protein (MBM and BM) diets. Dado *et al*. (1990) reported higher milk production (35 kg/cow/day) in cows fed Soy Plus than in cows fed unheated SBM (32 kg/cow/day). Similarly, in a study that evaluated the effect of replacing soybean meal with fishmeal (providing high levels of escape protein) in diets of high-producing dairy cattle, Broderick (1992) found that milk production increased in cows that had received fishmeal as compared to the soybean meal group. Concurrent with the results obtained in the current study, previous studies indicated that replacing soybean meal with undegradable protein sources improved milk production with no effect on the milk composition.

Experiment 2: Fattening Awassi lambs fed finishing diets

In our experiment with growing lambs fed either the SBM diet or SPM diet, intakes of DM, OM, CP, NDF and ADF were similar, whereas intake of RUP was higher in lambs fed the SPM treatment diet than in lambs fed the SBM treatment diet. These results are consistent with those of Nakamura *et al*. (1992), who observed that DM intake was similar when dairy cows were fed diets containing soybean meal or non-enzymatically browned soybean meal (soypass meal) and contained 16% crude protein. The non-enzymatically browned reaction of the soybean resulted in 79% of the protein as a bypass protein compared to 33% in the untreated soybean meal (Nakamura *et al*., 1992). In addition, Haddad *et al*. (2005) found no differences in DM and CP intake when lambs consumed diets with different levels of undegradable protein (from 2.6 to 4.7% of DM) in wheat straw based diets.

At the beginning of the experiment, the initial BW of lambs was similar (P>0.05) between the two diets. Final BW, total gain, ADG and feed conversion ratio were similar (P>0.05) between the diets. Soypass meal, a low degradable protein source, was expected to improve ADG when compared with soybean meal, the highly rumen degradable protein source. In the current study, replacement of the supplemental protein from soybean with soypass did not affect rate or efficiency of growth.

These results are consistent with those of Dabiri and Thonney (2004), who found that replacement of protein from soybean meal with protein from high quality fishmeal did not affect rate or efficiency of growth for early-weaned rapidly growing lambs fed diets containing 13, 15, or 17% CP. In contrast, Villalba and Provenza (2000) demonstrated that ADG improved by including bypass protein such as fishmeal in diets of growing lambs. Similarly, Stock *et al*. (1983) reported that growth rate and feed conversion ratio were enhanced in corn-based diets containing blood meal when compared to soybean meal. Furthermore, Haddad *et al*. (2005) found that rate of growth and efficiency improved when RUP increased as compared to a diet containing a low level of RUP. Similarly, in a study where xylose-treated SBM substituted 67% SBM in supplement/corn diets fed to calves weighing 75 kg, Thomas *et al*. (1992) found increased weight gain (1.46 vs 1.35 kg/d). Authors attributed these differences to improved nutrient (NDF and CP) digestibilities when lambs or calves consumed diets containing high levels of RUP as compared to low levels of RUP. Can *et al*. (2005) reported that rate of growth and efficiency were improved in lambs fed a diet containing bypass protein (fishmeal) when compared to rumen degradable protein in lambs fed finishing diets. These results are in agreement with others (Orskov *et al*., 1970; Beermann *et al*., 1986) who demonstrated that bypass protein that came from fishmeal enhanced the rate of growth of lambs more than diets containing plant protein sources. Willms *et al*. (1991) and Merchen and Titgemeyer (1992) speculated that supplementation with bypass protein in livestock can improve efficiency of growth and feed efficiency owing to enhancing the animals ability to deposit protein and, more importantly, improving the quality and quantity of amino acids reaching the small intestine for absorption, thus increasing the rate of growth and feed efficiency. However, results of the current study did not find this effect. The inconsistency of the effect of feeding soypass meal or any undegradable protein source on growth performance of lambs might be partially attributed to the ingredients presented in the control diet, level of feeding undegradable protein, and/or the feeding regime.

Conclusions

According to the conditions and the results obtained in the present experiments, it may be concluded that replacing soybean meal with xylose-treated soybean meal (SPM) did not improve the performance of nursing Awassi ewes and of their lambs except for the slight improvement in milk production in groups fed SPM. In addition, changing the degradability of the soybean meal by non-enzymatic browning (Maillard reaction) to increase escape protein did not improve the growth performance when compared to the untreated soybean meal in finishing diets containing 16% CP.

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