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The Nutritive Value of Sugar Beet Pulp-substituted Corn for Barki Lambs

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ABSTRACT

The experiment examined the effect of partial or whole replacement of yellow corn in growing Barki lambs rations by dried sugar beet pulp (SBP) on digestibility, blood parameters and growth performance. Forty Barki lambs averaged (30 kg live body weight) and 6 months old were divided into 5 groups of 8 lambs each for 90 days trial. All tested rations were contained concentrate feed mixture (CFM) and clover hay. Corn grains was the main source of energy in the CFM (SBP0), while 25, 50, 75 and 100% of CFM corn were substituted by SBP in SBP0, SBP50, SBP75 and SBP100, respectively. Results showed that SPB75 and SBP100 recorded higher ($P<0.05$) nutrients digestibilities with exception of ether extract. Rations' nutritive values as total digestible nutrients (TDN; $P=0.016$), digestible energy ($P=0.011$), metaboloizable energy ($P=0.001$) and digestible crude protein (DCP; $P=0.001$) were higher for SBP50 and SBP75 compared to the other treatments. All measured blood parameters were within normal ranges with a significant ($P<0.05$) effects of experimental rations on blood plasma parameters. Data of rumen parameters of showed insignificant effects of sugar beet pulp on volatile fatty acids. But there were a linear negative effect on ruminal pH and ruminal ammonia concentrations with SBP rations compared with control ration. The average daily gain indicated that SBP75 and SBP100 tended to have similar values ($P=0.638$) like SBP0. Feed conversion as kg DM/ kg gain was insignificantly differed ($P>0.05$) among the experimental rations whereas TDN and DCP per kg gain was significantly ($P<0.001$) higher for the animals fed SBP0. It could be concluded that SBP may be used as a partial or whole replacement of yellow corn on the rations of growing Barki lambs.

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Authors' Contribution
Both the authors conceived and designed the study and wrote the article. AEMM executed the work at farm. NSB performed chemical and biochemical analyses.

Key words
Corn grains, growing lamb, nutrients digestibility, sugar beet pulp.

INTRODUCTION

High-energy grain feeds are important components of the rations of farm animals. Feeding high-grain rations to growing animals can cause a maximum growth rates, better feed conversion and improved carcass characteristics, leading to increased profit opportunities (Bodas et al. 2007). However, feeding high grain-diets is usually associated with digestive disorders, such as rumen acidosis, reduced rumination and reduced saliva secretion, causing low performance (Ørskov and Ryle, 1990; Enemark *et al*., 2002). Replacement of high-energy grains with such other products as sugar beet pulp (SBP) is one means of reducing the use of high grains portion in diets of ruminants (Mandebvu and Galbraith, 1999). Sugar beet pulp is the solid residue after extracting sugar from sugar beets. It contains about 400 g/kg neutral detergent fiber (NDF) with a unique high concentration of neutral detergent soluble fiber, especially pectic substances (about 250 g/kg) (Voelker and Allen (2003). Partial or complete substitution of grains with pectin-rich feedstuffs, such as SBP, may prevent such disorders in the ruminal environment (Livesey *et al*., 2003) as their fermentation produces lower lactate and propionate than starch-rich feeds (Van Soest *et al*., 1991; Hall *et al*., 1998). The effects of substituting SBP for grains have been investigated previously (Alamouti *et al*., 2009; Mahjoubi *et al*., 2009); However, results of experiments with sheep and cattle on feed intake and animal performance being inconsistent (Mandebvu and Galbraith, 1999; Bodas *et al*., 2007), including positive and negative effects; ruminal pH was not always increased when cereal grains were substituted with sugar beet pulp (Mandebvu and Galbraith, 1999; Berthelot *et al*., 2001). Most of studies about using SBP in sheep ration were in partially substitution of barley or corn with SBP. Therefore, the aim of this study was to study the effects of partial or whole replacement of substitution of corn grain with SBP in the ration of growing Barki lambs on feed intake, animal performance, ruminal fermentation parameters and blood biochemical parameters.

MATERIALS AND METHODS

Animals, feeding and treatments

Forty Barki lambs with 30 kg body weight (BW) and 6 months old were divided into 5 groups of 8 animals

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each for 90 days trial, were used in a completely randomized design experiment. Lambs were fed a basal ration comprised of concentrate feed mixture (CFM) and clover hay (CH) with 70:30, respectively (Table I). The CFM contained (g/kg DM): 175 soybean meal, 200 wheat bran, 10 limestone, 10 salt, 5 mineral mix contained (g) 50 Zn, 50 Mn, 50 Fe, 10 Cu, 0.50 I, 0.10 Co and 0.20 Se plus $CaCo_3$ up to 2kg. Rations were formulated to cover lambs requirements of energy and protein according to NRC (1985). For control group, corn grains was used as the main source of energy in the CFM in control ration (SBP0), while corn grains were substituted with SBP with 25 (SBP25), 50 (SBP50), 75 (SBP75) and 100 % (SBP100). Fresh water was always available to animals. Rations were fed individually to each animal at 08:00 and 16:00 h in equal portions. The ingredient and nutrient composition of the rations are in Table I.

Orts were collected just before offering the next day feed. Lambs were weighed every two week before morning feeding after 15 h of fasting. Rations were adjusted every two weeks according to body weight changes (Khattab *et al.*, 2011). Body weight gain was recorded and daily feed intake was calculated. Dry matter, total digestible nutrients (TDN) and digestible crude protein (DCP) intakes were calculated. Feed conversion ratio was calculated as follow (intake kg/daily gain kg) for DM, TDN and DCP.

Nutrient digestibility and blood chemistry

At the end of growth trial, three lambs from each group were used to determine nutrients digestibility and nutritive values of the experimental rations. Fecal grab samples were collected daily during the last 3 d of the experimental period, dried at 60ºC in a forced-air oven for 48 h (Gallenkamp Vacuum Oven, Fistreem International Ltd, Leicestershire, UK). Acid insoluble ash was used as an internal marker where coefficients of digestion calculated according to Ferret *et al*. (1999). On the last day of the metabolism study, 10 mL of blood from each lambs was collected into a clean dry tubes contained EDTA as anticoagulant material from the jugular vein 4 h after feeding; centrifuged at 4,000×g at 4ºC for 20 min and blood plasma was separated into clean dried glass vials and frozen at -20ºC until analysis (Sanli® Blood Collection Tubes, Liuyang, China).

Chemical analysis and calculations

Dried feed, orts, feces samples were ground through a Wiley mill (Arthur H. Thomas, Philadelphia, PA, USA) using a 1 mm screen. Samples were analyzed for DM (#930.15), N (#954.01), ash (#942.05) and ether extract (EE; #920.39), according to AOAC (1997), while fiber fractionation (*i.e.* NDF and acid detergent fiber, ADF)

Table I.- Chemical composition (g/kg DM) and fiber fractions of experimental rations

Item	DM	OM	Ash	CP	CF	EE	NFE	NDF	ADF	ADL	Cellulose	Hemicellulose
Chemical composition of:												
Corn grain	890.0	982.0	18.0	86.5	29.2	48.3	818.0	90.0	22.0	10.0	20.0	68.0
Sugar beet pulp	910.0	940.7	59.3	96.2	219.8	06.6	618.1	430.0	270.0	20.0	250.0	160.0
Clover hay	930.5	962.9	73.1	159.9	15.5	387.3	364.2	948.3	429.7	94.1	335.50	68.7
Experimental rations†												
SBP0	914.8	927.9	72.1	152.3	112.7	38.6	624.3	297.3	250.5	50.3	200.3	46.8
SBP25	913.4	924.3	75.7	153.9	125.8	26.6	618.0	378.3	262.5	83.8	178.8	115.7
SBP50	919.7	924.2	75.8	154.2	145.6	25.4	599.0	386.6	286.4	86.1	200.3	100.3
SBP75	917.8	923.9	76.1	149.0	171.8	24.0	573.2	397.5	305.1	131.1	174.0	92.4
SBP100	921.8	914.2	85.8	160.2	188.0	15.6	550.3	428.1	325.7	168.0	157.6	102.4

†SBP contained (g/kg DM): SBP0: 420 corn grain + 0 sugar beet pulp + 300% clover hay + 280 concentrates, SBP25: 315 corn grain + 105 sugar beet pulp + 300 clover hay + 280 concentrates, SBP50: 210 corn grain + 210 sugar beet pulp + 300 clover hay + 280 concentrates, SBP75: 105 corn grain + 315 sugar beet pulp+ 300 clover hay + 280 concentrates, SBP100: 0 corn grain + 420 sugar beet pulp + 300 clover hay + 280 concentrates.

ADF, acid detergent fiber; ADL, acid detergent lignin; CP, crude protein; DM, dry matter; EE, ether extract; NDF, neutral detergent fiber; NFE, nitrogen free extract; OM, organic matter.

were completed according to Van Soest *et al*. (1991). Nitrogen free extract was calculated by difference.

Blood plasma parameters were analyzed using specific kits obtained from Stanbio Laboratory, Boerne, Texas, USA; for total protein and creatinine as described by Tietz (1986) and Tietz *et al.* (1990), albumin was determined according to Doumas *et al*. (1971), blood plasma urea was determined according to Patton and Grouch (1977). Alanin amino transferase (ALT) and aspartate amino transfearse (AST) activities were colorimetrically determined according to AST and ALT kits (Quimica Clinica Aplicada S.A., Spain) based on reaction of Young (1997).

Statistical analyses

Data were analyzed using the general linear model procedure of SAS (2001, Ver.8.02, SAS Institute Inc., Cary, NC, USA). One way ANOVA procedure used to analyze the digestibility, blood parameters, feed intake, growth rate data following the next model; $Y_{ij} = \mu + T_{ij} + e_{ij}$, were: µ is the overall mean of Y_{ij}; T_{ij} is the treatment effect; the e_{ij} is the experimental error. Results comparison were performed using Tukey's test at $P<0.05$ (Steel and Torrie, 1980).

RESULTS

Higher contents from ash, crude protein (CP), CF, NDF, ADF, ADL, cellulose and hemicellulose were observed with sugar beet pulp compared to corn grains. However, corn grains had higher content from OM, NFE and EE (Table I). Almost all the experimental rations had the same content from DM and OM. However, increasing the ratio of SBP in the rations linearly increased their content from CP, CF, NDF, ADF, and ADL with lowering their content from EE and NFE (Table I).

Ruminal pH before feeding and over the 4 h after feeding are shown in Table II. Rumen pH was significantly affected by the replacement percentage and sampling time. Inclusion of SBP in the ration resulted in linear ($P\geq0.05$) decreases in mean ruminal pH. The lowest and the highest mean ruminal pH values were observed in lambs fed SBP0 and SBP100, respectively (6.33 vs.5.97). For all rations, rumen pH decreased after the morning feeding and then increased. On contrast rumen pH ruminal ammonia concentrations were significantly lower with substitutions groups compared with control group (Table II). There were an obvious effects of treatment and sampling time. Substitution of SBP for corn grains caused decreases in mean ruminal ammonia concentration. The SBP0 treatment produced the highest mean ammonia concentration;however, no significant difference was found among SBP25, SBP50, SBP75 and SBP100. Ruminal ammonia concentration increased during the first four hours after the morning feeding and then decreased. No significant effects of treatments on total volatile fatty acids production in rumen (Table II). Results of total VFA showed that linear negative effect of substitution of yellow corn by SBP without significant difference at 4 hours after feeding, however SBP0 recorded higher value (15.26) and SBp100 recorded lower value (12.39).

For nutrient digestibility, the highest two replacement percents improved ($P\leq0.001$) DM, OM, ADF, NDF, CP, CF, ($P=0.026$) NFE, ($P=0.032$) cellulose and ($P=0.009$) hemicellulose. However, control group had the higher EE digestibility (Table 2). The same was observed for the ration nutritive value where both of SBP75 and SBP100 had the highest ($P=0.016$) TDN, DE ($P=0.011$), ($P=0.001$) ME, DCP values compared to the other rations (Table III).

Lambs of the control ration had higher values of plasma total protein, globulin and AST content. However, SBP25, SBP75 and SBP100 had higher ($P=0.049$) plasma urea content. Both of AST and ALT were in higher ($P<0.001$) values with SBP100 lambs. Moreover, SBP25 had the highest ($P<0.001$) creatinine content compared to the other groups (Table IV).

Almost all used lambs tended ($P=0.818$) to have the same initial body weight. However, lambs of both SBP75 and SBP100 tended to have a heavier ($P=0.665$) final body weight. Lambs of SBP100, SBP75 and SBP0 tended to have higher ($P=0.638$) average daily gain compared to the lambs of the other treatments.

Lambs of SBP75 and SBP100 consumed more ($P<0.001$) TDN and DCP than the lambs of the other treatments. However, no effects on DM intake were observed for different treatments. The same result obtained ($P<0.001$) for the feed conversion as a TDN and a DCP (Table V).

DISCUSSION

The nutrient content of the SBP used in the current experiment was typical for this type of feed and is in agreement with values reported by others (Longland *et al*., 1994; Moore-Colyer *et al*., 1997; Moore-Colyer and Longland, 2001). It was stated in previous studies, that the chemical composition of SBP is ranging from 9.33 to 10.71% for CP, 0.10 to 2.40% for EE, 18.40 to 22.37% for CF, 59.34 to 65.69% for NFE and 3.25 to 6.67% for ash on DM basis (Ali *et al.,* 2000; Talha *et al.,* 2002 and El-Badawi *et al.,* 2003). Also, it was reported that, the cell wall constituents of SBP were ranged from 62.4 to

Table II.- Effect of the experimental rations on rumen parameters.

Item	Experimental rations					MSE	P value
	SBP0	SBP25	SBP50	SBP75	SBP100		
pH							
Zero time	6.36[ab]	6.27[ab]	6.63[a]	6.66[a]	6.67[a]	0.104	0.068
4 hours post feeding	6.03[a]	5.46[b]	5.73[b]	5.30[b]	5.27[b]	0.095	0.023
Mean	6.33[a]	5.87[ab]	6.04[b]	5.98[b]	5.97[b]	0.085	0.046
Ammonia-NH3-N (mg/dL)							
Zero time	13.65[a]	11.76[b]	11.16[b]	11.16[b]	10.85[b]	0.34	0.036
4 hours post feeding	19.52[a]	15.58[b]	15.33[b]	15.86[b]	15.83[b]	0.52	0.016
Mean	16.57[a]	13.67[b]	13.25[b]	13.50[b]	13.12[b]	0.43	0.023
Total VFA's (meq/dl)							
Zero time	9.40	10.31	9.47	8.70	7.87	0.46	0.585
4 hours post feeding	15.26	14.13	13.64	13.06	12.39	0.47	0.418
Mean	12.33	12.22	11.55	10.88	10.13	0.45	0.565

Means in the same row with different superscript are significantly different (*P*<0.05).

Table III.- Effect of the experimental rations on digestion coefficients and nutritive values/

Item	Experimental rations					MSE	P value
	SBP0	SBP25	SBP50	SBP75	SBP100		
Nutrient digestibility (g/kg DM)							
DM	579.2[b]	565.2[b]	584.8[b]	716.6[a]	695.1[a]	6.34	0.001
OM	618.9[b]	662.6[b]	631.2[b]	768.0[a]	732.8[a]	18.40	0.001
CP	533.2[b]	550.4[b]	567.2[b]	786.0[a]	757.3[a]	12.64	0.001
CF	540.6[bc]	578.0[b]	598.9[b]	783.3[a]	723.9[a]	22/04	<0.001
EE	774.3[a]	632.3[b]	662.2[b]	704.9[b]	666.6[b]	7/26	0.001
NFE	542.7[b]	524.0[b]	540.0[b]	702.5[a]	694.7[a]	9.18	0.026
NDF	479.8[c]	520.2[c]	593.2[b]	704.8[a]	678.8[a]	7.28	<0.001
ADF	599.6[b]	506.1[c]	674.7[a]	717.9[a]	697.7[a]	7.82	<0.001
Cellulose	597.0[bc]	583.2[bc]	562.4[c]	713.1[ab]	752.9[a]	8.44	0.032
Hemicellulose	594.3[b]	562.3[b]	528.8[c]	761.9[a]	718.9[a]	38.40	0.009
Nutritive values							
TDN (%)	548.2[bc]	519.0[c]	536.0[bc]	698.8[a]	663.1[ab]	2.42	0.016
DE (MCal/kg)[1]	2.42[bc]	2.29[c]	2.36[bc]	3.08[a]	2.92[a]	0.011	0.011
ME (MCal/kg)[1]	1.99[bc]	1.86[c]	1.94[bc]	2.66[a]	2.50[ab]	0.012	0.001
DCP (%)	81.2[b]	84.7[b]	87.5[b]	121.7[a]	121.3[a]	0.218	0.001

Means in the same row with different superscript are significantly different (*P*<0.05).
ADF, acid detergent fiber; ADL, acid detergent lignin, CP, crude protein; DCP, digestible crude protein; DE, digestible energy; DM, dry matter; EE, ether extract; ME, metabolizable energy; NDF, neutral detergent fiber; NFE, nitrogen free extract; OM, organic matter; TDN, total digestible nutrients.
[1]Calculated according to NRC (2001)

62.5 for NDF, 27.60 to 27.64 for ADF, 2.5 to 2.9 for ADL, 24.7 to 25.1 for cellulose and 34.8 to 34.9 for hemicellulose (Helal *et al.*, 1998). The variation in nutrient composition in SBP may be due to the drying method used or the amount of molasses added back to the pulp.

Previous studies observed differences of responses in ruminal pH to the substitution of SBP for different grains. Bodas *et al.* (2007) reported that partial replacement of barley grain with SBP in the basal concentrate markedly increased ruminal pH (5.5 *vs* 6.7) and prevented ruminal acidosis in growing lambs. In contrast, Mahjoubi *et al.* (2009) noticed an linear increased in ruminal pH with the substitution of SBP for

Table IV.- **Effect of the experimental rations on blood parameters.**

Item	Experimental rations					MSE	P value
	SBP0	SBP25	SBP50	SBP75	SBP100		
Total proteins (g/dL)	6.00[a]	6.03[a]	5.83[ab]	5.50[b]	5.50[b]	0.294	0.019
Albumin (g/dL)	3.56[b]	3.96[ab]	3.93[ab]	4.03[a]	4.33[a]	0.106	0.026
Globulin (g/dL)	2.43[a]	2.06[ab]	1.90[ab]	1.46[b]	1.16[b]	0.128	0.001
Urea (mg/dL)	28.66[b]	31.66[a]	30.66[ab]	32.33[a]	31.66[a]	0.772	0.049
Creatinine (mg/dL)	0.60[c]	1.03[a]	0.70[bc]	0.76[b]	0.80[b]	0.022	<0.001
ALT (U/L)	23.00[b]	17.33[c]	18.[33c]	16.66[c]	25.66[a]	0.464	<0.001
AST (U/L)	20.00[b]	16.00[c]	16.66[c]	16.33[c]	22.00[a]	.0446	<0.001

Means in the same row with different superscript are significantly different (*P*<0.05).
ALT, alanin amino transferase; AST, aspartate amino transfearse.

Table V.- Effect of experimental rations on growth performance of Barki lambs.

Item	Experimental rations					MSE	P value
	SBP0	SBP25	SBP50	SBP75	SBP100		
Body weight cahnge							
IBW (kg)	30.33	30.25	30.17	30.00	29.08	0.678	0.818
FBW (kg)	46.96	45.89	45.90	47.50	47.98	1.308	0.665
TBW (kg)	16.63	15.64	15.73	16.50	16.90	0.664	0.638
ADG (g/day)	185	174	175	183	188	7.412	0.638
Feed intake (kg/lambs/d)							
DM	1.40	1.37	1.38	1.41	1.43	0.032	0.775
TDN	0.77[b]	0.71[b]	0.74[b]	0.98[a]	0.95[a]	0.016	<0.001
DCP	0.113[b]	0.117[b]	0.122[b]	0.172[a]	0.175[a]	0.020	<0.001
Feed convertion (kg)							
DM	7.59	7.94	7.92	7.97	7.63	0.208	0.726
TDN	4.16[b]	4.12[b]	4.25[b]	5.44[a]	5.06[a]	0.124	<0.001
DCP	0.62[c]	0.67[bc]	0.69[b]	0.95[a]	0.92[a]	0.022	<0.001

Means in the same row with different superscript are significantly different (*P*<0.05).
ADG, average daily gain; DCP, digestible crude protein; DE, digestible energy; DM, dry matter; FBW, final body weight; IBW, intial body weight; ME, metabolizable energy; TBW, total body weight gain; TDN, total digestible nutrients.

barley grain in late lactation cows diet of. However, ruminal pH was not affected in some studies when SBP replaced barley gains (Mandebvu and Galbraith, 1999; Mojtahedi and Danesh Mesgaran, 2011) or corn grains (O'Mara *et al.*, 1997; Voelker and Allen, 2003). The results of ammonia concentrations were compatible with Mandebvu and Galbraith (1999) observed that replacement of barley with SBP resulted in a linear decrease in ruminal ammonia concentration. Also findings in this study confirm those of Voelker and Allen (2003), who reported that rumen ammonia concentration was affected by inclusion of SBP in the ration. Nevertheless, many studies indicated no effect of SBP on ammonia concentration in rumen (Alamouti *et al.*, 2009; Bodas *et al.*, 2007; Mahjoubi *et al*., 2009). Ruminal ammonia concentration at any sampling time represent for the combination of ammonia production, ammonia absorption and microbial ammonia uptake and utilization (Mojtahedi and Danesh Mesgaran, 2011) . The decrease in ruminal ammonia concentration with dietary SBP content in the present study may be due to either slower release of ammonia from the diet or more rapid uptake by microorganisms. Decreasing total VFA concentration in the rumen of SBP fed to lambs could be partly due to dilution effect as result of higher water intake (data not recorded) because high water-holding capacity of SBP. However, the differences in ruminal VFA concentrations among treatments could be also related to alteration in fermentation pattern. These results agree with those reported by Ben-Ghedalia *et al*. (1989) in sheep, using dried citrus pulp and Voelker and Allen (2003) in lactating cows fed pellted beet pulp substituted high moisture corn.

The addition of SBP to the rations specially those of higher replacement percents (*i.e.* SBP75 and SBP100) of lambs resulted in a significant increase in the digestibility of all components with exception of EE content of the experimental rations, which is consistent with the findings of Alamouti *et al*. (2009), who reported that cows fed higher proportions of SBP exhibited higher apparent digestibility of DM and NDF. Voelker and Allen (2003) observed greater DM and NDF digestion when SBP replaced high-moisture corn in the ration of lactating dairy cows. In contrast, O'Mara *et al*. (1997) reported that SBP had no effect on the total tract DM digestibility of lactating dairy cows when it was substituted for corn.

Higher digestibility coefficients values of most nutrients as the result of increasing SBP proportion of tested rations may be attributed to the positive effect of feeding such of high quality ingredients (*i.e.,* SBP) which provided stimulatory factors to rumen cellulolytic and other bacteria. These factors resulted in some changes in digestive function which led to increasing the availability and utilization of nutrients in the rumen nutritive values of experimental rations. The feeding of SBP, a highly digestible fiber, may encourage growth of the cellulolytic and hemicellulolytic bacteria and fungi. This, in turn, should increase the extent of digestion of the ration. Also, the enhancement in total ration digestibility may be attributed to the fact that SB is rich in pectins and hemicelluloses, which are readily degraded by gut micro-organisms. El-Badawi and El-Kady (2006) explained that the high water holding capacity of dry SBP due to the existence of pectic substances, methyl and carboxyl groups in its molecular structure might be the reason of its better digestion. Inclusion of SBP in feeding of ruminants delays rate of passage outside the rumen (El-Badawi *et al.,* 2003) and increased methanogenic bacterial count, *Lactobacilli* and *Streptococci* and enzymatic yield of polygalacturonase and pectin esterase (El-Badawi *et al.,* 2001). In the same time, they have to pay attention that such high water absorptive capacity could eliminate feed intake by ruminants when SBP was fed as a sole ration (El- Badawi *et al.,* 2001). Hall *et al.* (1998) recorded that sugar beet pulp has a relatively high content of soluble and insoluble NDF, but it can be considered an energy concentrate because both soluble and insoluble NDF are highly digestible.

The nutritive values as TDN and DCP were matched with chemical composition of the experimental rations and digestion coefficients. The nutritive value of SBP could be fairly compared with that of high energy grain like barley, corn and oat. The TDN value of SBP was reported to range from 68 to 74%, with metabolizable energy averaging 2.99 Mcal for each kilogram on dry basis (Crawshaw, 1990; Mandebw and Galbraith, 1999). In addition, dried SBP is rich in sugar microelements (barium, boron, manganese, molybdenum and magnesium), macro elements (potassium, calcium, and magnesium) and amino acids (alanine, valine, leucine, proline and tryptophan) (Molotilin, 1999), but also it deficient in fat, phosphorus, carotene and certain B-vitamins (Bhattacharya and Sleiman, 1971).

Hamed *et al.* (2013) noticed the same trend of blood parameters values when fed Ossimi sheep on ration contained CFM consisted of 90% SBP plus 10% soybean meal. Also, Bodas *et al*. (2007) noted that there were insignificant differences between control and SBP groups for any of the blood parameters. They explained that the absence of effects on blood parameters may be due to the short duration of the fattening period. Abedo (2006) noticed that blood parameters included; total protein, albumin, globulin, ALT, AST and creatinine were not significantly differed among sheep groups fed different rations contained SBP and were within the normal range. However, Mojtahedi and Mesgaran (2011) found that plasma urea N before the morning feeding decreased linearly ($P<0.01$) with SBP inclusion with no treatment effect on plasma urea N at four hours after feeding. They explained their results due to the observed reductions in provision of ruminal ammonia for subsequent hepatic conversion to urea (Mandebvu and Galbraith, 1999).

Mandebvu and Galbraith (1999) noted that replacement of barley by SBP had no effect on food intake, growth rate or feed conversion efficiency. It is known that SBP has a high water-retention capacity and, hence, water intake may have been greater in lambs fed SBP than control concentrate, with a possible depressing effect on feed intake (Rouzbehan *et al*., 1994).

As shown in the obtained results, no significant differences among rations in initial, final, total and average daily gain. This may be due to the effect of SBP on chemical composition and nutrients digestibility of the tested rations. Corn has a lack uniform availability of nutrients, through the period for optimum degradation in the digestive tract of sheep fed *ad libitum*, even though digestive disturbance was not visually noticed (Bhattacharya *et al*., 1975). The same trend was noticed with Hamed *et al*. (2013) who showed that dietary treatment (CFM contained 10 % soybean meal and 90% SBP) had no significant effect on final body weight (40.43 kg), total body weight gain (10.12 kg) and average daily gain (181 g/day) during 56 days experimental period. Also, Bodas *et al*. (2007) noted that inclusion SBP in cereal-based rations for fattening lambs has no positive effects on animal performance. However, El-Badawi and El-kady (2006) showed that inclusion of SBP at 50% of CFM increased average daily gain (188 vs. 145 g/d for control of no SBP.

The observed higher feed conversion expressed as TDN and DCP per kg gain for the animals fed SBP75and SBP100 is in agreement with the findings of Bhattacharya *et al*. (1975) who reported that growing fattening sheep fed on a ration contained 45% SBP + 45% corn gained faster and required less feed per unit of gain than those fed on either 90% corn or 90% SBP. Similar results were also reported by Bouaque *et al*. (1976) on young bulls and Mandebvu and Galbraith (1999) on lambs.

CONCLUSION

It could be concluded that partial and whole replacement of yellow corn with sugar beet pulp may be recommended for rations of growing sheep with no adverse effect on their performance, digestion processes and rumen parameters and blood constituents.

Statement of Conflict of interest

The authors have declared no conflict of interest.

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