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UTILIZATION OF SUGAR BEET BY PRODUCTS IN FEEDING GROWING RAHMANI LAMBS

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Abstract: Twenty female Rahmani lambs with an average initial body weight 31.01±0.68 kg were randomly divided into four similar groups (5 in each group). To receive one of the tested rations, Ration1 containing 50% concentrate feed mixture 1 plus 50% berseem hay as a control ration. In rations 2 and 4, 50% of berseem hay was replaced by dry sugar beet tops. While, in rations 3 and 4, 50% energy ingredients (yellow corn grains, wheat bran and rice bran) were replaced by dry sugar beet pulp in concentrate feed mixture 2. Ration 3 had significantly (P<0.05) the highest digestibility coefficient of all nutrients followed by rations 4 and 2, while, while ration 1 had the lowest values. Digestible crude protein had nearly the same trend, but total digestible nutrients and digestible energy were significantly higher in ration 3 compared with the other rations. A logarithmic scale of acidity or basicity of rumen liquor were nearly similar for all the different groups. Dry sugar beet pulp in rations 3 and 4 showed significantly the higher concentrations of total volatile fatty acids and ammonia nitrogen compared to the other rations. Dry sugar beet pulp increased dry matter, total digestible nutrients, digestible crude protein and digestible energy, but tended to decrease with dry sugar beet tops compared with control group. Growth rate and feed conversion were significantly higher (P<0.05) for lambs fed ration 3 compared with the other rations. Lambs fed ration 3 recorded significantly the highest net revenue and economic efficiency.

Key words: growing lambs; dry sugar beet pulp; dry sugar beet tops; growth performance

Introduction

In Egypt, there is a shortage of available fed for ruminant. So that a growing attention is being focused on the use of crop by-products such as sugar beet by-products. Using of these by-products will decrease the fed cost as well as limitation the environmental pollution.

In 2017 a large area was (about 545000 feddans) cultivated with sugar beet in Egypt, which produced about 650000 tons of dried sugar beet pulp (DSBP) as a by-product of' sugar beet manufacture. It also produced about 6.8 million tons of fresh sugar beet tops (FSBT) as an agricultural by-product (3).

Sugar beet pulp may be used as a partial or whole replacement of energy sources in mixed rations of ruminants (21, 17). Also, dried sugar beet tops (DSBT) was used as good roughage in feeding ruminants with appreciable reduction

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in feeding cost without any health troubles (6, 22, 4 and 12).

The objectives of this study were to investigate the effect of feeding female Rahmani lambs on ration containing DSBP as partial replacement 50% of energy sources (Yellow corn grains, wheat bran and rice bran) and/or DSBT as partial replacement 50% of berseem hay (BH) on feed intake, digestibility, rumen fermentation activity, some bloods parameters, growth performance, fed conversion and economic efficiency.

Material and methods

The present study was carried out during summer 2017 at private farm, El-Hamol, Kafr El-Sheikh Governorate, Egypt in cooperation with the Animal Production Department, Faculty of Agriculture, Kafrelsheikh University, Egypt.

Sugar beet tops (SBT) were collected after harvesting sugar beet crop and spread on ground, then turning it from time to time (before sunrise and after sun down) till drying (the drying period was about 7 days) then material was collected and stored. While DSBP was obtained from the Dakahlia Company of Sugar, Dakahlia Governorate as a by-product of sugar beet industry.

Twenty female Rahmani lambs weighted 31.01±0.68 kg were used in feeding trial that lasted 90 days. Animal were divided into four similar groups (5 lambs each). Animals were randomly assigned in to four experimental ratios. R1 containing 50% concentrate feed mixture (CFM1) plus 50% berseem hay BH (control ration). In R2 and R4 50% of BH was replaced by DSBT, while, in R3 and R4 50% of energy sources (yellow corn grains, wheat bran and rice bran) in CFM1 were replaced by DSBP in CFM2. Crude protein in CFM2 was adjusted by adding 0.6 urea (46% N) to compensate the lower protein content in DSBP. Each 1 ton of CFM1 contained 110 kg soybean meal, 300 kg yellow corn grains, 300 kg wheat bran, 250 kg rice bran, 10 kg common salt, 15 kg limestone, 7.5 kg premix, 5 kg sodium bicarbonate and 2.5 kg yeast culture. Whereas, CFM2: 50% from sources of energy (yellow corn, wheat bran and rice bran) were replaced by DSBP with addition 4.2 kg urea over the 1 ton to adjust protein content.

Animals were weighed before morning feeding on 2 consecutive days at the beginning and at the end of the experimental and once biweekly during the experimental period. At the end of the feeding trial, three lambs from each group were used in three digestion trials to evaluate the previous rations by using acid insoluble ash (AIA) technique (29). Samples of feed ingredients, ration and feces were taken for chemical analysis according (1). Digestible energy was calculated as follows: DE= TDN× 0.04409 (24).

At the last day of the digestibility trail, rumen liquor samples were taken 3 hr after the morning feeding by a rubber stomach tube. The samples were filtered through a double layer of cheese cloth. The rumen pH value was determined directly by HANNA pH meter (HI-8424 Sophisticated micro-processor, pH meter). The rumen samples were transferred into covered plastic tubes with two drops of formalin for stopping microbial activity and kept in a deep freezer until analysis. Total volatile fatty acids (TVFA's) concentration was estimated by using steam distillation method (30). While Ammonia-N (NH_3-N) concentration was determined using magnesium oxide (Mgo) as described by (1)

Blood samples taken at the same time of rumen liquor collection from the jugular vein in clean tubes and then were centrifuged at 2500 rpm for 20 minutes to separate blood serum using serological pipettes. Samples of whole blood were collected using EDTA as anticoagulant and immediately directed to hematological determination. Different items of the blood picture were carried out, the counts of red blood cells (RBC's) and white blood cells (WBC's) (20), hemoglobin (Hb) (9), total protein (TP) (8), albumin (AL) (14) and GOT and GPT (26). The data were analyzed using IBM SPSS Statistics general linear models procedure (15).

Results and discussion

Results in Table 1, revealed that a variation in chemical composition among the different feed ingredients. The CF content was higher, whereas the contents of CP and NFE were lower in DSBP compared to the average of other energy sources (yellow corn grains, wheat and rice bran). It reflects the differences in CF and NFE contents between CFM1 and CFM2, while CP content was adjusted in CFM2 by adding urea to become nearly the same for both concentrate feed mixtures. Also, CP content was nearly similar for both BH and DSBT. While, CF content was higher, but NFE and ash contents were lower in BH compared with DSBT. The calculated composition of experimental rations showed that CP content was nearly similar for different rations. Moreover, CF content increased with DSBP (R3), but it decreased with DSBT (R2). However, NFE content had opposite trend, which decreased with DSBP (R3 and R4) and increased with DSBT (R2). The EE content decreased with DSBP R3 and R4. Ash content increased with DSBT (R2). Similar results found that introducing DSBP in rations of buffaloes and sheep resulted in an increase in CF content (10, 25). Also, replacing BH by DSBT in rabbit's ration decreased CF content and increased NFE and ash contents (13).

The digestibility coefficients and nutritive values of experimental rations are shown in Table (2). The digestibility coefficient off all nutrients in R3 (containing DSBP) had the highest significantly values ($P<0.05$) followed by R4 (containing DSBP + DSBT) and R2 (containing DSBT) while, the R1 (control) had the lowest values. The DCP% had the same trend nearly but, the TDN and DE values were significantly higher in R3 compared with the other rations. The improvements of digestibility and nutritive values with DSBP might be due to their higher fiber content (Table 1), which reduce the outflow rate of feed in the rumen as well as urea nitrogen supplemented with DSBP may be stimulate the rumen microorganisms. Although, the digestibility coefficients of all nutrients improved with DSBT compared to BH. These results agreed with those obtained by (23) indicated that using DSBP at level 25 and 50% in growing Angora goats rations increased the digestibility of DM, OM, CP and CF as well as nutritive value as TDN than control ration. On the other hand, (18) feeding Rahmani rams on complete pelleted rations with replacing 50 and 100% of BH by DSBT significantly increased the digestibility of DM, OM and NFE but, the digestibility of CP and EE and the values of TDN and DCP were decreased significantly higher. (4) concluded that DSBT could be used successfully as a replacer to 50% from BH in ration of growing lambs without any detritus effects on productive and reproductive performance.

Rumen liquor parameters presented in Table (3) showed that pH values were nearly similar for the different groups. The pH values of all rations were between 6.47 and 6.60 which were with the normal range (27). No significant differences in rumen pH values were detected while, the concentration of total VFA's and NH_3-N significantly increased between Rahmani rams consuming rations containing different levels of DSBP (0, 25 and 50%) as replacement of concentrate mixture, (5). Rations 3 and 4 contained DSBP showed significantly ($P<0.05$) higher concentrations of TVFA's and NH_3-N while, the lower TVFA's concentration was in R1 and NH_3-N concentration was in R2. Adding urea with concentrate feed mixture containing DSBP (CFM2) led to increase ruminal NH_3-N concentration, which simulate rumen microorganisms utilizing resulting in more fermentation of soluble carbohydrates and structure fiber producing VFA`s. (23) indicated that the total VFA's concentration significantly increased as the proportion of DSBP increased in the Angora goats ration. (11) didn't find any significant differences in the ruminal pH between Rahmani rams fed different rations containing 100% BH as control or rations contained 50 and 100% of BH were replaced by DSBT.

Results of blood hematology in Table (3) revealed significant differences ($P<0.05$) in the counts of white and red blood cells among the different groups, which R4 had the highest values followed by R3 and R2, while R1 had the lowest values. However, hemoglobin concentration and hematocrit percentage were nearly similar for different groups. The values of blood hematology obtained in this study were within the normal range for sheep being 5-14.5 x 10^3/µl for WBC's, 8.2-12.3 x 10^6/µl for RBC's, 9-14 g/dl for hemoglobin and 25-38% for hematocrit (28).

Serum parameters in Table (3) showed that the concentrations of total protein and globulin were significantly ($P<0.05$) higher in R3 and R4 followed by R2, while R1 had the lower values. On the other side, the concentrations of glucose and total lipids as well as the activity of GOT and GPT were significantly ($P<0.05$) higher in R1 followed by R2, while both R3 and R4 had the lower values. These results revealed that DSBP was more effective in whole blood and serum parameters than that DSBT. While, (4) found that no significant differences on blood parameters when lambs fed ration contained DSBT as replacement of BH at rate 50 and 100 % compared with control group (BH). (25) declared that incorporation SBP in sheep ration decreased plasma concentrations of triglyceride, cholesterol, urea and uric acid compared to control ration (CFM). Finally, all serum blood parameters values were within the normal range.

Table 1: Chemical composition of ingredients, concentrate feed mixtures and experimental rations

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
Ingredients							
Soybean meal	92.46	89.70	44.04	5.38	2.09	38.19	10.30
Sources of energy							
Yellow corn grains	91.42	98.68	9.49	1.74	4.23	83.22	1.32
Wheat bran	90.49	95.18	13.89	9.04	3.76	68.49	4.82
Rice bran	90.41	87.87	13.97	9.52	15.29	49.09	12.13
Average	90.77	93.91	12.45	6.77	7.76	66.93	6.09
Dry sugar beet pulp	89.28	95.91	9.70	24.98	2.18	59.05	4.09
Berseem hay	89.45	89.70	13.45	27.64	2.45	46.16	10.30
Dry sugar beet tops	87.65	79.18	13.78	12.74	2.28	50.38	20.82
Concentrate feed mixtures							
CFM1	91.21	90.22	15.48	6.22	6.45	62.07	9.78
CFM2	90.60	90.96	15.49	13.97	4.25	57.25	9.04
Experimental rations							
R1 (control)	90.33	89.96	14.46	16.93	4.45	54.12	10.04
R2	89.43	84.70	14.63	9.48	4.37	56.22	15.30
R3	90.03	90.33	14.42	20.80	3.35	51.76	9.67
R4	89.58	87.70	14.53	17.08	3.31	52.78	12.30

Table 2: Digestibility coefficients and nutritive values of experimental rations

Item	R1	R2	R3	R4	SEM
Digestibility coefficients, %					
DM	65.25^{c}	66.42^{bc}	68.13^{a}	67.70^{ab}	0.38
OM	66.30^{c}	67.03^{b}	69.28^{a}	67.50^{b}	0.35
CP	66.53^{c}	67.03^{bc}	69.09^{a}	67.45^{b}	0.31
CF	61.48^{c}	63.60^{b}	66.30^{a}	64.25^{b}	0.55
EE	76.50^{c}	78.90^{bc}	82.73^{a}	80.03^{b}	0.74
NFE	64.05^{c}	67.48^{b}	69.28^{a}	67.65^{b}	0.58
Nutritive values, %					
TDN	62.35^{b}	61.45^{b}	65.85^{a}	62.44^{b}	0.56
DCP	9.62^{c}	9.82^{b}	9.96^{a}	9.80^{b}	0.04
DE, Mcal/kg DM*	2.75^{b}	2.71^{b}	2.90^{a}	2.75^{b}	0.02

a, b, c: Means in the row with different superscripts differ significantly (P<0.05)

Table 3: Rumen liquor, whole blood and serum parameters of growing lambs in experimental groups

Item	R1	R2	R3	R4	SEM
Rumen liquor					
pH value	6.47	6.50	6.60	6.55	0.03
TVFA's (meq/100 ml)	12.11^{b}	13.19^{ab}	14.82^{a}	14.46^{a}	0.38
NH_3-N (mg/ 100 ml)	16.32^{ab}	15.28^{b}	19.50^{a}	18.60^{ab}	0.72
Whole blood					
WBC's (x $10^3/\mu l$)	8.12^{b}	8.57^{ab}	9.05^{ab}	9.50^{a}	0.23
RBC's (x $10^6/\mu l$)	9.74^{b}	10.39^{ab}	10.68^{ab}	11.10^{a}	0.24
Hb (g/dl)	9.67	9.97	10.57	10.97	0.27
HTC (%)	26.77	26.83	27.20	27.37	0.37
Blood serum					
Total protein	7.13^{b}	7.60^{ab}	8.07^{a}	8.13^{a}	0.15
Albumin	3.83	3.88	3.97	4.00	0.05
Globulin	3.30^{b}	3.72^{ab}	4.10^{a}	4.17^{a}	0.15
Glucose	51.00^{a}	48.67^{a}	45.33^{b}	45.33^{b}	0.82
Total lipids	153.00^{a}	149.00^{a}	135.33^{b}	133.00^{b}	3.11
GOT	46.78^{a}	44.67^{ab}	43.56^{b}	41.89^{b}	0.65
GPT	16.67^{a}	15.67^{ab}	14.83^{b}	14.50^{b}	0.32

a, b: Means in the row with different superscripts differ significantly (P<0.05)

Table 4: Average daily feed intake, live body weight, total and daily weight gain of growing lambs in experimental groups

Item	R1	R2	R3	R4	SEM
Average daily feed intake:					
As fed basis, kg/head/day:					
CFM1	0.718	0.696	-	-	
CFM2	-	-	0.740	0.725	
Berseem hay	0.718	0.348	0.725	0.362	
Dry sugar beet tops	-	0.348	-	0.362	
Total	1.436	1.392	1.480	1.449	
As dry matter basis, kg/head/day:					
DM	1.297	1.245	1.332	1.298	
TDN	0.809	0.765	0.877	0.810	
DCP	0.125	0.122	0.133	0.127	
DE, cal/head/day*	3.56	3.37	3.86	3.57	
Live body weight, total and daily weight gain:					
Duration (day)	90	90	90	90	
Initial weight (kg)	31.38	30.58	30.83	31.24	0.68
Final weight (kg)	43.16^{ab}	42.37^{b}	44.06^{a}	43.23^{ab}	0.98
Total weight gain (kg)	11.78^{b}	11.79^{b}	13.23^{a}	11.99^{b}	0.47
Average daily gain (g)	130.89^{b}	131.00^{b}	147.00^{a}	133.22^{b}	5.23
Relative growth rate, %	37.54^{b}	38.55^{b}	42.91^{a}	38.38^{b}	0.97

a, b: Means in the row with different superscripts differ significantly (P<0.05)

Feed intake as dry matter, TDN, DCP and DE was nearly similar for all groups (Table 4). (4) and (2) showed that no significant differences (P>0.05) in total dry matter and crude protein intake by sheep fed rations containing DSBP.

Live body weight, total and daily weight gain of growing lambs in different experimental groups are shown in Table (4). While, final live body weight, total and average daily body weight gain were significantly (P<0.05) higher for lambs fed R3 contained DSBP compared with the other groups. The relative growth rate of lambs fed R1, R2, R3 and R4 were 37.54, 38.55, 42.91 and 38.38%, respectively. These results showed that DSBP achieved the higher growth rate of growing lambs, which confirmed with higher digestibility and nutritive values (Table 2) and rumen fermentation activity (Table 3). These results agreed with those obtained by (16) who found that increasing average daily gain of lambs fed diet containing 25 or 50% DSBP as a replacer of CFM. (12) showed that average daily gain of lambs was significantly higher with replacing yellow corn by DSBP. (18) didn't find any significant differences in average daily gain of growing lambs fed rations containing DSBT at rate 0, 50 and 100% in complete pelted rations as replacement of BH. (11) reported that no significant differences for the average daily gain of crossbred ewe lambs fed rations containing DSBT as a replacement of BH (0, 50 and 100% DSBT).

Feed conversion of growing lambs fed the experimental rations presented in Table (5). Incorporation of dry sugar beet pulp and tops in rations of growing lambs significantly (P<0.05) improved feed conversion. Lambs in control group fed R1 showed the highest amounts of DM, TDN, DCP and DE required per one kg live weight gain, whereas those fed R3 containing DSBP had the lowest values of DM and DCP and those fed R2 containing DSBT had the lowest TDN and DE values. The improvement of feed conversion with DSBP attributed to the improvement of ADG (Table, 5).

Table 5: Feed conversion and economic efficiency of growing lambs in experimental groups.

Item	R1	R2	R3	R4	SEM
Feed conversion:					
DM, kg/kg gain	9.91^{a}	9.50^{ab}	9.06^{b}	9.74^{ab}	0.15
TDN, kg/kg gain	6.13^{a}	5.84^{b}	5.97^{ab}	6.08^{ab}	0.06
DCP, kg/kg gain	0.955^{a}	0.931^{ab}	0.905^{b}	0.953^{a}	0.03
DE, Mcal/kg gain	27.20^{a}	25.73^{b}	26.26^{ab}	26.80^{ab}	0.23
Economic efficiency:					
Feed cost (LE/day)	4.00^{a}	3.03^{c}	3.40^{b}	3.31^{b}	0.07
Feed cost LE/ kg gain	30.56^{a}	23.23^{b}	23.13^{b}	24.85^{b}	1.26
Output of weight gain (LE/day)	7.20^{b}	7.21^{b}	8.09^{a}	7.33^{b}	0.29
Net revenue (LE/day)	3.20^{c}	4.18^{ab}	4.69^{a}	4.02^{b}	0.29
Net revenue improvement %	0.00^{c}	30.63^{ab}	46.56^{a}	25.63^{b}	0.65
Economic efficiency	1.80^{c}	2.38^{a}	2.38^{a}	2.21^{b}	0.07

a, b, c: Means in the row with different superscripts differ significantly (P<0.05)

Moreover, feed intake decreased with feed DSBT (Table, 4). These results are illustrated with those obtained by (19) who found that efficiency of feed utilization was markedly improved in cows fed beet pulp as compared with those given corn. (16) reported improvement in feed efficiency of lams by feeding in rations containing DSBP at rate 25 or 50% as replacing of CM. (11) showed that feed efficiency (kg feed DM/kg gain) was nearly similar when fed crossbred ewe lambs on rations containing DSBT as a replacement of HB (0, 50 and 100% DSBT) and were no significant differences for all groups.

Results of economic efficiency in Table (5) showed that feeding rations contained DSBP and DSPT significantly (P<0.05) reduced average daily feed cost compared to control group and the lowest value was with DSPT in R2. In addition, feed cost per one kg weight gain was significantly (P<0.05) higher with control group compared to the other groups containing DSBP and/or DSPT. This may be due to the lower price of DSBP than those of corn gain, wheat and rice bran as well as lower price of DSBT than that of BH. Meantime, R3 contained DSBP had significantly (P<0.05) the higher output of daily weight gain compared with the other groups, which attributed to higher ADG of lambs fed R3 (Table, 5). Moreover, lambs fed R3 recorded significantly (P<0.05) the highest net revenue followed by R2 and R4, while R1 had the lowest values. Furthermore, lambs fed R2 and R3 had significantly (P<0.05) the highest economic efficiency followed by R4, while R1 had the lowest value. These results agreed with those obtained by (7) who found that feed cost per kg liveweight gain decreased with increasing amounts of DSBP in the rations. (25) reported that replacing CFM with SBP supplemented with 10% soybean meal (SBM) in sheep ration led to decrease total daily feeding cost and Feed cost LE/ kg gain and improved daily profit by 38.07% compared to control ration. (4) and (11) reported that feed cost as LE/kg gain decreased significantly with improved the economic efficiency for crossbred ewe lambs on rations containing DSBT as a replacement of HB (50 and 100% DSBT) compared with control

Conclusion

From these results it could be concluded that replacing 50% of energy sources (yellow corn, wheat bran and rice bran) by dried sugar beet pulp and replacing berseem hay by dried sugar beet tops in rations of growing lambs improved their performance concerning digestibility, rumen fermentation activity, blood parameters, growth rate, feed conversion and economic efficiency.

Conflict of interest

Authors declare that no conflict of interest.

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