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Effect of Partial Replacement of Concentrates with Sugar Beet Pulp on Performance, Carcass Characteristics and Energy Utilization of Growing Sheep

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ABSTRACT

Twelve five months old (Ossimi X Rahmani) male lambs weighing 20.80 ± 2.60 kg were used to evaluate the effect of feeding ration containing 50% (w/w) feed sugar beet pulp to replace the common concentrate feed mixture (CFM) on carcass traits, body composition and utilization efficiency of metabolizable energy by growing Egyptian sheep. Four lambs randomly chosen were slaughtered at the beginning of the feeding experiment to detect the initial body composition. The remained eight lambs were blocked by their weight into two groups (I & II) where both groups were fed individually on two rations. Ureated un-molassed dry sugar beet pulp (USBP) was weekly prepared by spraying a solution of 30 g urea dissolved in 100 mL water per kg of beet pulp. Two feed mixtures containing 0 and 50% (w/w) USBP in replacement of CFM were fed for groups I and II, respectively. Experimental mixtures in mash were offered at 4% of body weight once daily at 8.00 a.m., while chopped fresh berseem (*Trifolium alexandrium*) was daily fed at one kg/head after four hours of the morning meal. Offered amounts of concentrate mixtures were bi-weekly adjusted according to changes of body weight and feed refusals were daily collected. Experimental period (168 day), at the end of the feeding trials two digestibility trials was carried out on three animals of each group. Slaughter technique was applied after digestibility trials on four animals of each group. The results showed that both of CP and EE digestibilities were decreased with ration containing 50% USBP, CF digestibility was extremely higher than that of the traditional feed mixture. Dietary nutritive value expressed in terms of TDN was higher by about 5% for the 50% USBP mixture than control however differences of both TDN and DCP between the two mixtures did not attain any significance. Inclusion of USBP at 50% of the common CFM increased average daily gain by nearly 30%. Consequently feed conversion in terms of kg DM or TDN per kg gain was significantly ($P < 0.05$) better for the group fed 50% USBP. Empty body weight, warm carcass weight and dressing percentage were much better for lambs fed 50% USBP rations, however yields of edible and non edible offal's were slightly higher for lambs fed the CFM, while the percentage of bone was much lower ($P < 0.05$) for lambs fed 50% USBP ration. The finger print of the eye muscle showed that the muscle area for the four slaughtered lambs fed the 50% USBP ration were significantly greater than those fed the CFM. (29.63 ± 5.22 cm vs. 23.62 ± 2.79 cm). Protein and fat contents of carcass were higher for lambs fed 50% USBP ration. Utilization efficiency of metabolizable energy (ME) for net energy gain (NEg) was ($P < 0.05$) higher for lambs fed 50% USBP. It could be concluded that inclusion of 3% ureated sugar beet pulp in 50% replacement of CFM can be recommended in rations of growing sheep.

Key Words: Sheep; Nutritive value; Gain; Carcass traits; Energy utilization

INTRODUCTION

Beet pulp is the residue left from ground sugar beet after sugar extraction. It comprises about 6% of the total fresh weight of harvested sugar beet (Kjaergaard, 1984). Sugar beet pulp (SBP) is available in the local market in dry un-molassed cubes about (90% DM) and it is usually used as an energy source feed-stuff for ruminants.

Chemical composition of the dried SBP is ranging between 83.8 - 92.5% dry matter (DM), 9.3 - 10.7% crude protein (CP), 0.10 - 2.4% ether extract (EE), 18.4 - 22.4% crude fiber (CF), 59.3 - 65.7% nitrogen free extract (NEF) and 3.25 - 6.67% ash on DM basis (Bhattacharya & Sleiman, 1971; Castle, 1972; Kelly, 1983; NRC, 1989; Mansfield *et al*., 1994). About 85% of the nitrogenous substances of dried SBP are presented in the form of true protein. Growth performance of Egyptian fat-tailed sheep (Ossimi, Rahmani & Barki) was frequently studied during different stages of age and different feeding systems. Daily weight gain between 109 to 172 g had been recorded for local breeds of sheep fed on confinement system (Soliman *et al*., 1975; El-Bedawy *et al*., 1993). Higher average daily gain ranging from 145 to 379 g with an overall mean of 225 g/d have been reported by Shehata (1997) with 2501 local finishing lambs fed *ad libitum* (3.7% DMI of body weight) on 100% concentrate ration. El-Serafy *et al*. (1984) applied initial and final slaughter technique with 30 (Merino X Rahmani) lambs, and found that NEg Kcal/kg$^{0.75}$ EBW gain was increased from 2.788 to 4.943 as the level of concentrates increased from 50 to 70% in the ration. The energy conversion of ME to NEm for sheep was almost constant under different feeding regimes (Rattray *et al*., 1973; El-Serafy *et al*., 1984; Ortigues & Vermorel, 1996; Jassim *et al*., 1996), while ME conversion to NEg was variable among genotypes of sheep (NRC, 1985; Stankov *et al*., 1995; Afonso & Thompson, 1996). Moreover, incremental heat loss was noted to range from 10 to 90% of the ME depending on diet composition, feeding system and physiological status of the animal (NRC, 1985).

The aim of this work was to evaluate the impact of feeding sugar beet pulp in partial replacement of the common concentrate feed mixture on nutritive value, carcass traits, body composition and utilization efficiency of performance energy utilization by growing local sheep.

MATERIALS AND METHODS

Twelve cross-bred (Ossimi X Rahmani) male lambs aged five months old weighed in average 22.92 kg $\pm$ 2.60 were used in a feeding experiment lasted 168 days. Four lambs weighed 22.50 $\pm$ 2.48 kg randomly chosen were slaughtered at the beginning of the feeding trial to determine the initial body composition of experimental animals. The remaining eight lambs were allotted at random into two groups (I & II) and kept indoor in two semi-opened pens where both groups were fed individually. Ureated un-molassed dry sugar beet pulp (USBP) was weekly prepared by spraying a solution of 30 g urea dissolved in 100 mL water per kg of beet pulp. Two feed mixtures containing 0 and 50% (W/W) USBP in replacement of common concentrate feed mixture (15.20% CP on DM basis) were formulated to be fed for groups I and II, respectively.

Experimental mixtures in mash were offered at 4% of body weight once daily at 8.00 a.m.; while chopped fresh berseem (*Trifolium alexandrium*) was daily fed at one kg/head after four hours of the morning meal. Feed consumption and feed refusals were daily collected, sun dried and weekly recorded. Offered amounts of concentrate mixtures were bi-weekly adjusted according to changes of body weight. Drinking water was freely available at all times. At the end of the feeding period, two digestibility trials were carried out on three animals of each group to evaluate nutrient digestibility and nutritive values.

Each trial lasted 15 days, preliminary and collection periods lasted for 10 and 5 days, respectively. Experimental slaughter technique was applied on all animals of each group after 24 h fasting period. Slaughtered animals were left to bleed for 5 min. and the drained blood was collected, weighed and representative composite sample of each group (250 mL) was taken for chemical analysis. External and internal offal's along with the hot carcass were separately weighed. Contents of the digestive tract were removed, collected and weighed to obtain the empty body weight (EBW) by subtracting the gut fill from the fasting body weight (FBW). Dissected carcass components (lean, fat & bone) was carried out for the whole carcass and the relative weight of each component was proportionally calculated as percentage of EBW. A finger-print of the eye-muscle (longesmus dorsi) from the left side of the 13^{th} rib was stamped on a sketch paper and the muscle area was determined by the planimeter. Carcass mince meat, edible offal's (liver, heart, kidneys & spleen) and ground bone of the carcass were separately prepared and representative samples of each were individually analyzed. By similar procedures, samples of non-edible offal's (head, legs, lungs & trachea, clean digestive tract & testicles) were prepared and sampled. An individual sample area (30 x 30 cm) of the hide was taken shredded, minced and pooled representative sample from each group was chemically analyzed. The whole initial and final body composition was estimated as the sum of nutrients in edible and non-edible parts expressed in kg for slaughtered animals.

Chemical analysis of feed, feces and body constituents (fat, protein & ash) were carried out according to A.O.A.C. (1984) procedures.

Calculation of energy utilization. Energy of the ration was calculated as g TDN x 4.409 Kcal for DE (NRC, 1975) and ME (Kcal) as DE x 0.82 (NRC, 1985). Energy retention in the whole body (NEg) was estimated from the difference between final and adjusted initial body composition. Energy content was estimated as the sum of total body protein x 5.570 (Mcal/kg) plus the total body fat x 9.354 (Mcal/kg), according to Garrett *et al*. (1959).

The maintenance metabolizable energy was determined (g TDN/kg$W^{0.75}$) being 111.7 Kcal ME/kg$W^{0.75}$ for growing Ossimi sheep (El-Badawi *et al*., 1999). The metabolizable energy of gain was determined by the difference between metabolizable energy of intake and metabolizable energy of maintenance.

The net energy for maintenance (NE_m)-fasting metabolism was taken as 79.4Kcal NE/kg$W^{0.75}$ for lambs (Rattray *et al*., 1973).

Incremental heat loss of ME was calculated by difference [(ME - (NE_m + NE_g)]. Collected data were subjected to statistically analysis of variance using the T-test to detect the significant differences between I and II groups for measured parameters. According Snedecor and Cochran (1980), the general linear models of SAS (1982) were used to process data obtained.

RESULTS AND DISCUSSION

Proportional replacement at 50% (w/w) of the common concentrate feed mixture based on cotton seed meal, yellow corn and wheat bran by 3% ureated sugar beet pulp did not effectively influenced the chemical proximate analysis of the feed mixture. However, it seems clear that CF content was increased to 17.08% for the 50% USBP mixture than 14.61% for the common CFM (Table I). Results of nutrients digestibilities, nutritive value and feed conversion of the experimental feed mixtures are given in Table II. Both of CP and EE digestibilities were decreased with the feed mixture containing 50% USBP, while CF digestibility was extremely higher than that of the traditional feed mixture. Williams *et al*. (1987) on Friesian bull calves and Eweedah *et al*. (1999) on Merino lambs found that both CP and EE digestibilities were significantly decreased by feeding rations containing SBP in replacement of grains or concentrate mixtures. It was noted earlier, that the CP of SBP is poorly digested by ruminants (Metwally & Stern, 1988). Moreover, the high water holding capacity of dry

Table I. Chemical composition of experimental feeds

Item	DM	DM Composition, %				
	%	CP	EE	CF	NEF	Ash
100% CFM (1)*	88.61	15.20	2.50	14.61	60.28	7.41
50% CFM+50% USBP(II)	89.30	15.26	1.82	17.08	59.90	5.94
Berseen fodder	18.00	13.09	2.00	24.76	43.09	17.06

Common feed mixture consisting of (on as fed basis): 30% undecorticated cotton seed meal, 30% yellow corn, 30% wheat bran, 7% cane-molasses, 2% lime stone and 1% sodium chloride.

Table II. Nutrient digestibility, nutritive value and growth performance of sheep in experimental groups

Item	Experimental groups	
	I (Control)	II (50% USBP)
Mean body weight, kg	45.33	51.83
Mean daily DM intake, kg	1.71	1.82
DMI of body weight, %	3.77	3.49
OM	70.92	75.53
CP	69.15	65.74
EE	74.07	55.00
CF	55.92	74.90
NFE	75.07	78.79
Nutritive value on DM basis (±SD), %		
TDN	67.60±3.12	72.69±1.62
DCP	10.43±0.59	9.99±0.29
Growth performance:		
No. of animals	4	4
Feeding period, day	168	168
Initial body weight, kg (±SD)	23.15±6.27	23.12±5.64
Final body weight, kg (±SD)	47.58±9.64^{b}	54.83±9.20^{a}
Average daily gain, g (±SD)	145.4±22.10^{B}	188.5±25.43^{A}
Feed conversion, kg/kg gain (±SD)		
DM	8.89±0.92^{a}	7.23±0.82^{b}
TDN	6.01±0.62^{a}	5.26±0.59^{b}

Table III. Adjusted initial body composition of experimental growing sheep in experimental groups

Item	Experimental groups	
	I (0% USBP)	II (50% USBP)
No. of animals	4	4
Live body weight , kg	22.66±3.88	20.12±3.78
Carcass composition , kg		
Water	6.11±1.04	5.42±1.02
Protein	1.68±0.29	1.49±0.28
Fat	2.14±0.37	1.90±0.36
Ash	0.71±0.12	0.63±0.12
Edible offals composition, g		
Water	436.5±74.52	387.2±72.70
Protein	106.5±17.97	94.5±18.08
Fat	29.7±5.50	27.0±5.16
Ash	10.8±1.71	9.5±1.29
Non-edible offals & Trimmings composition, kg		
Water	5.58±0.96	4.96±0.93
Protein	1.59±0.27	1.41±0.26
Fat	0.56±0.10	0.50±0.09
Ash	0.50±0.08	0.44±0.08

sugar beet pulp might prevent the enzymatic hydrolysis of dietary fat in the rumen media (Mohamed *et al.,* 2000). On the other hand, CF digestibility of 50% USBP was obviously higher than the corresponding value of the common CFM. Values of CF and NFE digestibilities of 50% USBP were closely similar (74.90% for CF & 78.79% for NFE). In this regard, Mansfield *et al.* (1994) stated that CF content of SBP could be digested as effectively as NFE fraction in rations of Holstein cows. Dietary nutritive value expressed in terms of TDN was higher by about 5% for 50% USBP mixture than the control one, however, differences for both TDN and DCP between the two mixtures did not attain significance.

Results of growth performance for experimental sheep (Table II) showed that inclusion of USBP at 50% of CFM increased, average daily gain increased by nearly 30% in comparison with those fed the common CFM (188.5 vs. 145.5 g/d). Feed conversion in terms of kg DM or TDN per kg gain was significantly ($P < 0.05$) better for the group fed 50% USBP. These results are in agreement with the findings of Bhattacharya *et al*. (1975), who reported that growing fattening sheep fed on a diet contained 45% DSBP + 45% corn gained faster and required less feed per unit of gain than those fed on either 90% corn or 90% DSBP. Similar conclusions were also reported by Bouaque *et al.* (1976) on young bulls and Mandebvu and Galbraith (1999) on lambs.

From our previous work, we do believe 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 Streptcocci and enzymatic yield of polygalacturonase and pectinesterase (El-Badawi *et al*., 2001). In the same time, we 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).

Initial, final body composition and carcass characteristics of slaughtered lambs are given in Tables III, IV and V. Empty body weight, warm carcass weight and dressing percentage were much better for lambs fed 50% USBP ration, however yields of edible and non-edible offal's were slightly higher for lambs fed the common CFM. Lean meat calculated relative to carcass weight was similar in experimental groups (68.83 for 0% USBP & 68.92% for 50% USBP ration). Knife-separable fat (KSF) weight was insignificantly higher for lambs fed 50% USBP, while the percentage of bone was much lower ($P < 0.05$) for lambs fed 50% USBP ration.

The finger print of the eye muscle shown in (Fig. 1), illustrates that the muscle's area for the four slaughtered lambs fed on 50% USBP ration were greater than those fed on the common CFM ration (29.63 vs. 23.62 cm^2, respectively).

The final body composition for the whole body (carcass, edible & non-edible offal's and trimmings) were similar in its water content for the two experimental groups (59.25 & 59.81% of the EBW). Body protein content calculated relative to empty body weight was higher for lambs fed 0% SBP ration, while the protein content of the carcass was higher for lambs fed 50% USBP ration. Such difference in protein content of the whole body is fairly referred to the higher protein content of non-edible offal's

Table IV. Carcass Characteristics of finally slaughtered sheep in experimental groups

Item	Experimental groupes		Sd^{-}
	I (0% USBP)	II (50% USBP)	
No. of slaughtered animals	4	4	
Fasting body weight (FBW), kg	46.25±5.56	50.25±7.60	6.66
Empty body weight (FBW), kg	38.76±3.89	43.25±6.70	5.48
Warm carcass weight, kg	21.70±3.92	25.09±4.12	4.02
Dressing of EBW, %	55.66±4.45	57.96±0.97	3.22
Edible offals, kg(i)	0.99	1.07	
of EBW, %	2.56±0.19	2.48±0.06	0.14
Non-edible offals & Trim., kg(ii)	16.07	17.09	
of EBW	41.77±4.34	39.56±0.93	3.14
Dissected carcass traits			
Lean, kg	14.97	17.29	
, %	68.83±1.30	68.92±3.44	2.60
KSF, kg	2.56	3.56	
%	11.77±0.92	14.12±3.74	2.72
Bone, kg	4.17	4.24	
%	19.40±1.39^{a}	16.96±0.50^{b}	1.05

Sd^{-} = Pooled standard error; * Knife – separable fat, includes: tail + pelvic kidney – viscera; (i) Include: liver, heart, de-fatted kidneys and spleen. (ii) Include: head, legs, lungs & trachea, clean GIT, testicles, hide and blood.

Table V. Final body composition of slaughtered sheep in experimental groups

Item	Experimental groups		Sd^{-}
	I (0% USBP)	II (50% USBP)	
Empty body weight, kg	38.76±3.89	43.25±6.70	
Carcass composition, kg			
Water	11.83±2.13	13.58±2.22	
Protein	3.64±0.65	4.11±0.68	
Fat	5.10±0.95	6.15±1.12	
Ash	1.13±0.20	1.25±0.20	
Edible offals composition, g			
Water	724.1±34.21	774.0±104.11	
Protein	185.0±8.43	205.3±27.06	
Fat	57.9±2.11	69.1±10.23	
Ash	23.0±1.081	22.3±.2.18	
Non-edible offals & Trimmings,kg			
Water	10.40±0.47	11.51±1.72	
Protein	3.66±0.20	3.43±0.46	
Fat	1.09±0.05	1.38±0.20	
Ash	0.92±0.05	0.77±0.10	
Final whole body composition (kg or % of EBW)			
Water, kg	22.95	25.86	
%	59.25±0.34	59.81±0.50	0.43
Protein, kg	7.48	7.75	
%	19.34±0.44	17.92±0.39	0.41
Fat, kg	6.25	7.60	
%	16.06±0.81	17.55±0.91	0.86
Ash, kg	2.08	2.04	
%	5.35±0.03	4.72±0.11	0.08

Sd^{-} = pooled standard error

and trimmings which consisted nearly 48% of EBW of slaughtered lambs in group I (0% SBP). Ether extract content was much higher in carcass and edible offal's of lambs fed 50% USBP ration.

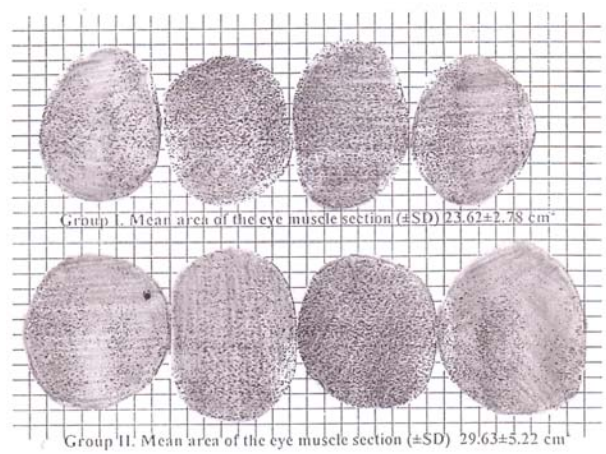
Weight gain composition in terms of energy deposition is shown in Table VI. Total energy gain during the whole feeding period was 74.871 Mcal and 55.791 Mcal for lambs fed 50% USBP and 0% SBP ration, respectively. Most of the difference of energy gain between the two experimental groups could be regarded to the higher body fat of lambs fed 50% USBP ration. Energy gain from fat deposition consisted 64.75% and 59.01% of the total energy

Table VI. Weight gain composition, energy gain distribution and net energy gain (NE_g/d) for growing sheep in experimental groups

Item	Experimental groups		Sd^{-}
	I (0% USBP)	II (50% USBP)	
Feeding period, day	168	168	
Average EBW gain, g/d	115.0±7.06^{b}	154.5±21.49^{a}	15.99
Carcass, kg			
Water	5.72±1.10	8.16±1.30	1.21
Protein	1.96±0.37	2.62±0.44	0.41
Fat	2.96±0.59	4.25±0.79	0.70
Ash	0.42±0.08	0.62±0.11	0.10
Energy Gain, Mcal	38.605	54.347	
Edible offals, g			
Water	287.5±48.95	387.7±35.71	42.84
Protein	78.5±11.21^{b}	110.2±10.44^{a}	10.83
Fat	28.0±3.65^{b}	41.7±4.99^{a}	4.37
Ash	12.5±0.58	13.0±1.16	0.91
Energy Gain, Mcal	0.699	1.004	
Non-edible offals & Trimmings, kg			
Water	4.82±1.11	6.55±0.80	0.97
Protein	2.07±0.41	2.01±0.20	0.32
Fat	0.53±0.12^{b}	0.89±0.11^{a}	0.11
Ash	0.42±0.11	0.33±0.02	0.08
Energy Gain, Mcal	16.487	19.520	
Total energy gain, Mcal	55.791±5.113	74.871±11.129	8.66
Energy gain in edible parts, %	70.45	73.94	
Energy gain from fat, %	59.01	64.75	
Calorific value Mcal/kg EBW gain	2.886±0.148	2.880±0.121	0.13

Sd^{-} = pooled standard error; Each g fat and protein = 9.354 and 5.570 kcal, respectively (Garrett et al., 1959); a,b means with different superscripts in the same row are different at $P<0.05$.

Fig. 1. Figure-print from the left side of the eye muscle (longesmus dorsi) for the four slaughtered animals fed on 0% USBP (group I) or 50% USBP (group II)



gain of lambs fed 50% USBP and 0% SBP ration, respectively. Utilization efficiency of metabolizable energy (ME) for net energy gain (NEg) was ($P < 0.05$) higher for lambs fed 50% USBP ration than the control one (32.7% vs 25.2%; Table VII).

Introduction of 3% ureated sugar beet pulp to replace 50% of the common concentrate mixture is recommended in rations of growing sheep and could provide a safe source of carbohydrates with longer time of passage rate and consequently better utilization of dietary energy.

Table VII. Utilization efficiency of metabolizable energy for maintenance and gain by growing Ossimi sheep fed on experimental rations (calculations were carried on an individual basis)

Animal No.	FBW kg	$kgw^{0.75}$	DMI kg/d	TDN kg/d	Metabolizable energy, Mcal Intak(i)	ME_m(ii)	ME_g	Net energy, Mcal NE_m(iii)	NE_g	Utilization efficiency of ME to NE_{m+g}	to NE_m	to NE_g
Group (0% USBP)												
1	29.90	12.79	1.151	0.778	2.609	1.429	1.180	1.016	0.333	51.7	71.0	28.2
2	29.25	12.58	1.146	0.775	2.599	1.405	1.194	0.999	0.292	49.7	71.0	24.5
3	34.88	14.35	1.325	0.896	3.005	1.603	1.402	1.139	0.336	49.1	71.0	24.0
4	38.86	15.57	1.434	0.969	3.250	1.739	1.511	1.236	0.366	49.3	71.0	24.2
Mean (±SD)										49.9±1.19		25.2^b±1.99
Group II (50% USBP)												
1	28.24	12.25	1.059	0.770	2.582	1.368	1.214	0.973	0.377	52.3	71.0	31.1
2	32.37	13.57	1.100	0.780	2.616	1.516	1.100	1.077	0.401	56.5	71.0	36.5
3	36.55	14.87	1.325	0.963	3.230	1.661	1.569	1.181	0.496	51.9	71.0	31.6
4	41.25	16.26	1.400	1.018	3.414	1.816	1.598	1.291	0.508	52.7	71.0	31.8
Mean (±SD)										53.3±2.12		32.7^a±2.52
Sd^-										1.72		2.27

(i) ME kcal = g TDNX 3.615 (NRC, 1985); (ii) 111.7 Kcal ME/$Kgw^{0.75}$ for growing Ossimi sheep (El-Badawi et al., 1999); (iii) 79.4 Kcal NE/$Kgw^{0.75}$ for lambs (Rattray et al., 1973); Sd^-= Pooled standard error; a,b Means with different superscripts in the same column are different at $p < 0.05$.

REFERENCES

A.O.A.C., 1984. *Official Methods of Analysis. 13th Ed*., Association of Official Analytical Chemists. Washington, D.C. USA

Afonso, J. and J.M. Thompson, 1996. Changes in body composition of sheep selected for high and low backfat thickness, during periods of ad-libitum and maintenance feeding. *Anim. Sci*., 63: 395–406

Bhattacharya, A.N. and W.T. Sleiman, 1971. Beet pulp as a grain replacement for dairy cows and sheep. *J. Dairy Sci*., 54: 89–94

Bhattacharya, A.N., T.M. Khan and M. Uwayjan, 1975. Dried beet pulp as a sole source of energy in beef and sheep rations. *J. Anim. Sci*., 41: 616

Bouaque, C.H.V., B.G. Cottyn, J.V. Aerts and F.X. Buysse, 1976. Dried Sugar beet pulp as a high energy feed for beef cattle. *Anim. Feed Sci. Technol*., 1: 643–53

Castle, M.E., 1972. A comparative study of the feeding value of dried sugar beet pulp for milk production. *J. Agric. Sci*., 78: 371–7

El-Badawi, A.Y., M.I. Mohamed and I.M. Awadalla, 1999. Effect of feeding regime on body composition and utilization efficiencies of ME for NE_m and NE_g for Ossimi lambs during finishing-growth period. *Egypt J. Nutr. Feeds*, 2: 17–28

El-Badawi, A.Y., M.H.M. Yacout and H.E.M. Kamel, 2003. Effect of replacing corn with sugar beet pulp on ruminal degradation kinetics and utilization efficiency of rations by growing sheep. *Egypt J. Nutr. Feeds*, 6: 1349–63

El-Badawi, A.Y., R.I. El-Kady, T.M. El-Bedawy and M.Z. Sedik, 2001. Inclusion of sugar beet pulp in ruminant diets. 2. Changes of rumen fermentation, microbial count and enzymatic activity associated with feeding different levels of ureated sugar beet pulp in rations of growing sheep. *Egypt J. Nutr. Feeds*, 4: 113–24

El-Bedawy, T.M., A.Y. El-Badawi, S.A. Ahmed and E.A. Gihad, 1993. Effect of dietary protein level on nutrient utilization, rumen fermentation and composition of body changes of Rahmani sheep and zaribi goats. *Egypt. J. Anim. Prod*., 30: 251–62

El-Serafy, A.M. S.M. Ahmed, H.M. Aly, H.M. Kattab, H.S. Soliman and M.A. El Ashry, 1984. NE_m and NE_g values of rations containing different roughage to concentrate ratio. *Egypt J. Anim. Prod.*, 24: 99–105

Eweedah, N.M., S.A. Mahmoud, G. El-Santiel and M.F. Ali, 1999. Utlization of sugar beet by-products in feeding ruminants. 1- Digestiblity, rumen fermentation and nutritive value. *Egypt J. Nutr. Feeds,* 1: 121–30

Garrett, W.N., J.H. Meyer and G.P. Lofgreen, 1959. The comparative energy requirements of sheep and cattle for maintenance and gain. *J. Anim. Sci*., 18: 528–47

Jassim, R., S.A. Hassan and A.N. Al-Ani, 1996. Metabolizable energy requirements for maintenance and growth of Awasi lambs. *Small Ruminants Res*., 20: 239–45

Kelly, P., 1983. Sugar Beet Pulp-a review. *Anim. Feed Sci. Technol*., 8: 1–18

Kjaergaard, L., 1984. Examples of biotechnological utilization of beet pulp and bagasse. *Sugar Technol. Rev*., 10: 183–237

Mandebvu, P. and H. Galbraith, 1999. Effect of sodium biocarbonate supplementation and variation in the proportion of barley and sugar beet pulp on growth performance and rumen, blood and carcass characteristics of young entire male lambs. *Anim. Feed Sci. Technol*., 82: 37–49

Mansfield, H.R., M.D. Stern and D.E. Otterby, 1994. Effect of beet pulp and animal by-products on milk yield and *in-vitro* fermentation by rumen microorganisms. *J. Dairy. Sci*., 77: 205–16

Metwally, H.M. and M.D. Stern, 1988. Effects of dietary carbohydrates and protein sources on ruminal fermentation and protein supply to the small intestine of dariy cattle. *J. Anim. Sci.*, 66: 95–9

Mohamed, S.A., T.M. Mohamed and A.Y. El-Barawi, 2000. Impact of enzymatic hydrolysis of polysaccharidies in sugar beet pulp on cell.-wall constituents and in-vitro dry matter disappearance. *Arab Univ. J. Agric. Sci*., 8: 425–37

NRC, 1975. *National Research Council. Nutrient Requirements of Sheep. 5th Rev. Ed*. National Academy of Science, Washington, D.C. USA

NRC, 1985. *National Research Council-Nutrient Requirements of Sheep 6th Rev. Ed*. National Academy of Science, Washington, D.C. USA

NRC, 1989. *Nutrient Requirements of Dairy Cattle 7th Ed*. National Research Council. National Academy Press, Washington, D.C. USA

Ortigues, I. and M. Vermorel, 1996. Adaptation of whole animal energy metabolism to under nutrition in ewes influence of time and posture. *Anim. Sci*., 63: 413–22

Rattray, P.V., W.N. Garrelt, H.H. Meyer, G.K. Bradford, N. Hinman and N.E. East, 1973. Net energy requirements for growth of lambs age three to five months. *J. Anim. Sci*., 37: 1386–9

SAS, 1982. *User's Guide*: Statistics SAA Inst., Gray, NC

Shehata, E.I., 1997. Report on a new approach for more economic lambs fattening system. *Egypt J. Anim. Prod*., 34: 115–23

Snedecor, G.W. and W.G. Cochran, 1980. *Statistical Methods. 7th Ed*. Allied Pacific, Bombay

Soliman, H.S., M.A. El-Ashry and O. Shehata, 1975. Different energy and protein levels in rations for fattening lambs. Effect on body weight gain and feed efficiency of Rahmani lambs. *Egypt J. Anim. Prod*., 15: 19–32

Stankov, I., S. Raichev, M. Petev and S. Stoichev, 1995. Fattening and meat traits of lambs of Bulgarian aboriginal breeds. *Bulgarian J. Agric. Sci*., 1: 459–63

Williams, P.E.V., R.J. Fallon, G.M. Innes and P. Garthwait, 1987. Effect on feed intake, rumen development and live weight of calves of replacing barley with sugar beet-citrus pulp in a starter diet. *Anim. Prod.*, 44: 65–73

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