The effect of feeding diets of different molasses levels on rumen fermentation digestibility, nitrogen balance and body weight gain in yearling sheep.

Muna, M.M. Ahmed, Sara, R. Beheri [1] and A.A. Lutfi[2]

Institute of Environmental Studies. P. 0. Box 321. Khartoum-Sudan.

SUMMARY

The effect of different molasses levels (30, 35, 40, and 45%) in the diet of sheep was investigated. Four rations were formulated so as to be iso-caloric and iso-nitrogenous, and in which the different molasses levels replaced groundnut hulls in a basal ration of wheat bran and groundnut cake. 32 yearling sheep were subjected to two trials, feeding and digestibility, where in the former a completely randomized design was used with eight animals in each treatment and in the latter a 4X4 Latin Square design was used. The results revealed that dry matter intake decreased steadily with the increase of molasses level, but no significant differences could be detected. Body weight gain increased ($P<0.05$) with the 30 and 40% molasses levels although the amounts of nitrogen retained decreased ($P<0.05$) with the 40% level suggesting that the gain in weight could be due to fat deposition. Higher ($P<0.05$) amounts of nitrogen retention were observed with the 30 and 35% levels. Ether extract digestibility at the 35% level proved to be significant ($P<0.05$). Rumen pattern of fermentation or blood urea nitrogen did not differ much with the different diets. However, the sampling time showed that, rumen pH and rumen ammonia nitrogen decreased while rumen volatile fatty acids increased 6 hours post-feeding but without significant differences.

INTRODUCTION

Molasses is an inexpensive and valuable energy source, readily available worldwide that has been used for ruminants feeding (Niino *et al.*, 1992). It could be utilized for several purposes, in dry feed, in silage making as urea carrier, in liquid supplements and in molasses blocks (Goll, 1981). Due to its laxative effect, digestive disturbances might arise and so a 20% level is recommended as maximum level (Scary, 1988). Other authors went up to 30% without adverse effect (Sibanada *et al.*, 1987).

Digestibility of dry matter of sheep showed an improvement upon addition of 10% molasses to desert grasses (Mirgani and Bakit, 1990) or to a commercial mixture (Leontwicz *et al.*, 1982). Similar results were obtained when molasses was used to replace different diets such as rice bran (Lenal *et al.*, 1989), rice straw (Nakanishi 1992) or corn (Hatch and Beeson, 1972). Furthermore, crude protein digestibility was also found to be increased by the inclusion of molasses at 10 or 20% levels (Karalazos and Swan, 1972) or added to a basal diet of meadow grass hay (Weidmeier *et al.*, 1992) or sodium hydroxide treated straw (El Yassin and Fonterot, 1991). Above 30% level, molasses addition was found to have no effect on fiber digestibility (Lemal *et al.*, 1989).

Best weight gain was obtained with 30% inclusion of molasses in the diet of sheep (Pollot and Ahmed, 1979). Daily weight gain of 900g for cattle fattened on 40% molasses feeds was also observed (Cleasby, 1953).
In zebu bull a.970g/day was recorded (Preston *et al.*, 1969). Inclusion of molasses in the diet of sheep was found to increase both intake (Ahmed and Ahmed, 1983) and forage utilization (Kalili et al., 1993). The present study was initiated with the objective to investigate **the** effect of inclusion of molasses at different levels (30-45%) in sheep fattening diets on rumen fermentation pattern, digestibility, nitrogen balance, and weight gain.

MATERIAL AND METHODS

Experimental Animals:

Thirty-two uncastrated healthy yearling desert rams were used in this experiment. They aged between 1-1.5 years and weighed between 27-29 ± 1.2 kg at the beginning of the experiment.

Feeds:

Four rations containing increasing molasses levels (30, 35, 40, and 45%) were formulated to meet the nutrient requirements of sheep (Table 1) and were designated as rations 1, 2, 3, and 4 respectively. The chemical composition of the experimental rations is shown in Table 2. Feed samples were analyzed at regular intervals according to the methods of Association of Official Analytical Chemists (AOAC, 1980).

Table 1. Percentage of ingredient of experimental rations, on dry matter basis.

Ration / Ingredient	1	2	3	4
Molasses	30	35	40	45
Wheat bran	28.3	28.3	28.3	28.3
Groundnut hulls	35	30	25	20
Groundnut cake (GNSC)	4	4	4	4
Urea	1.7	1.7	1.7	1.7
Salt	1.0	1.0	1.0	1.0
Crude protein	15.25	15.18.	15.13	15.08
Metabolizable energy (MJ/kg DM)	9.75	9.96	10.16	10.37

Table 2. Chemical composition of the experimental rations.

Ration / %	1	2	3	4
Dry matter	85.9	84.2	82.8	89.4
Organic matter	76.73	71.70	74.38	75.18
Ether extract	2.18	0.28	1.26	1.0
Crude fiber	20.68	20.22	14.61	14.22
Crude protein	15.26	13.93	12.68	14.22
Nitrogen free extract	52.66	52.53	63.05	56.68
Ash	9.22	12.5	8.4	8.58

Feeding Trials:

The 32 rams were allocated to a completely randomized design where each group of eight animals received one of the formulated rations shown in Table 1. To avoid responses that might have arisen from variations in body weights, animals' allocations to the different treatments were so that the average body weights in the different groups were nearly the same. The animals were individually tethered in partially shaded enclosures (6 x 6 m^2) fenced with thatch fitted together with wire at a height of 2 m. An adaptation period of 14 days was allowed followed by a measurement period of 12 weeks during which food intake and water intake of each animal was taken and body weights recorded on weekly basis. Food was withdrawn overnight before weighing was done in the next morning. The duration of this, study lasted for 98 days.

Digestibility Trial:

At the end of the feeding trial, four animals were randomly selected from each group, fitted with fecal bags, and placed in metabolic cages especially designed for urine collection. In the digestibility trial, the animals were employed to a 4X4 Latin Square design, (4 animals versus 4 treatments). The animals were rotated between the treatments so that there were 16 animals per treatment. During each rotation the animals were allowed an adaptation period of 7 days followed by 7 days measurement period so that this trial lasted for 56 days. During each measurement period, urine samples were collected and analyzed for nitrogen content according to El Shazly (1958), feces analyzed for proximate analysis using the standard methods of AOAC (1980). Rumen liquor samples were collected by a stomach tube, strained through a mesh cloth, and analyzed immediately for pH, ammonia nitrogen (NH_3-N) and total volatile fatty acids (VFAs). The pH was measured by a pH meter (Electronic measurement L. T. D. model 4160), NH_3-N determination followed the method of Conway (1957) while VFAs was determined by steam distillation as described by Kroman *et al.* (1967). Blood samples were collected for urea determination level. This was done by jugular vein puncture in nonheprinized tubes, the serum separated was stored at —20˚C until assayed for urea serum concentration by the method of Evans (1968).

All of the above samples were taken twice, once before feeding and once 3 hours post-feeding. Animals were fasted overnight for the before feeding samples.

Statistical Analysis:

Analysis of variance was done according to the general linear model procedure of SAS (1990). Duncan multiple range test was used to examine differences between means at a < 0.05.

RESULTS

Chemical composition:

The chemical composition of the rations showed that differences due to the inclusion of molasses was not significant. However, ration 1 had the highest ether extract and crude fiber concentrations, while ration 3 had the highest nitrogen free extract concentration.

Dry matter intake (DMI) and body weight gain:

Total weight gain (Kg) over the experimental period (12 weeks) or average daily weight gain (g) was found to be significantly ($P<0.05$) low with ration 4 (45% molasses diet) (Table 3). DMI, when expressed as g/d or g/kg$^{0.75}$/day was found to decrease with the increase of molasses level in the rations. However, significant differences could not be detected.

Table 3. Body weight gain, dry matter intake (DMI) and water intake of desert sheep fed different molasses levels over 12 weeks.

Ration / Parameter	30	35	40	45
Initial weight (kg)	28.3+1.3	28.0+1.0	27.2+2.4	26.4+1.0
Final weight (kg)	30.1+1.6	34.3+2.5	35.2+1.8	28.1+2.3
Total gain (kg) over				
89 days	7.1±3.5^{a}	6.3±1.3a^{b}	10.1+2.2^{a}	3.0±2.4^{e}
Average daily gain(g)	83.0±0.9^{a}	73.0±0.04^{a}	99±0.06^{a}	36.0+0.1^{b}
Dry matter intake (DMI,				
kg)	1.07+0.01	1.03+0.03	1.02+0.03	0.71+0.02
g / kg$^{0.75}$/ day	87.2+3.1	84.63+5.3	84.62+4.4	60.94+6.2

Values are means of eight animals ± SD

^{abc} Values within the same row bearing different superscript differ significantly at ($P<0.05$).

Ruminal components and blood urea nitrogen (BUN):

Sampling time was found to affect ruminal components (Table 4). Both the pH and ammonia nitrogen (NH3-N) decreased 6 hours post-feeding, while total volatile fatty acids (VFAs) increased. BUN seemed to be inconsistent with sampling time. Statistical analysis were carried out for the treatment means between the different rations and no significant differences were detected .

Table 4. Ruminal pH, total volatile fatty acids (VFAs, meq/100 ml), Ruminal ammonia nitrogen (NH_3-N, mg/100 ml) and blood urea nitrogen (BUN, m1/100 ml) of desert sheep fed different molasses levels over 12 weeks.

Rations / Parameters '	30	35	40	45
pH before feeding	7.25±0.39	7.17±0.31	7.20±0.31	7.18±0.48
pH 6 hrs post-feeding	6.70±0.34	6.66±0.19	6.76±0.06	6.73±0.26
VFAs before feeding	0.95±0.27	0.92±0.49[b]	1.01±0.40[b]	1.06±0.32[b]
VFAs 6 hrs post-feeding	1.6±0.47	2.28±0.69	2.07±0.74	1.77±0.23
NH3-N before feeding	27.83±4.4	26.95±10.4	29.93±3.5’	26.78±5.4
NH3-N 6 hrs **post-feeding**	9.63±6.8	12.95±5.8	9.65±10.7	10.33±3.0
BUN before feeding	34.09±8.4	24.11±3.2	22.86±7.9	31.18±8.2
BUN 6 hrs post-feeding	33.75±4.7	26.61±6.7	34.94±10.6	34.09±8.3

Digestibility:

Apparent digestibility of the nutrients is shown in Table 5. Ether extract digestion was shown to be the highest (P<0.05) with ration 1(30%) compared to the other rations. Crude fiber digestion was the lower (P<0.05) with rations 3 and 4 compaed to rations 1 and 2. Nitrogen free **extract was** the lowest (P<0.05) with ration 2 (35%).

Table 5. Apparent digestibility coefficients and total digestible nutrients (TDN, %) and digestible crude protein of different levels of molasses fed to desert sheep.

	Molasses level (%)			
	30	35	40	45
Apparent digestibility				
Dry matter	61.44±9.7	56.52±3.1	61.68±6.5	63.88±4.1
Organic matter	78.10±7.7	76. 99± 6.3	80 . 62±3. 3	84.5±4.2
Crude protein	75.99±12.1	65.13±9.9	66.02±6.1	71.19±1.4
*DCP	11.5±1.3	9.07±0.09	8.35+0.2	10.12±1.4
Ether extract	87.76±7.6[a]	31.0±7.7[b]	26.25±3.3[b]	42.63±9.8[b]
Crude fiber	44,36±17.9[a]	47.92±11.9[a]	26.67±12.6[b]	30.98±12.6[b]
Nitrogen free				
Extract	67.10±9.7[a]	63.34±5.3[b]	74.68±5.1[a]	71.10±6.4[a]
TDN	59.61±9.3	52.63±3.2	60.05±4.9	53.78±5.1

* DCP = digestible crude protein.

Values are means of eight animals ± SD.

[ab] Values within the same row bearing different superscript differ significantly at (P<0.05).

Nitrogen balance:

Significant differences in nitrogen intake, or excretion in feces and urinary due to inclusion of molasses at different levels could be detected (Table 6). However, there was a tendency of animals to decrease intake but increase fecal excretion at 40% level. The amount of nitrogen retained when expressed as percent of intake or digested revealed that both the 30 and 35% molasses levels in the rations **increased** significantly ($P<0.05$) compared to the 40 and 45% **levels.**

Table 6 Nitrogen balance of desert sheep fed different molasses level.

Nitrogen balance	Molasses level (%)			
	30	35	40	45
Nitrogen intake (g / day)	24.81±0.97	22.71±0.53	17.71±0.48	20.63±2.3
Fecal N.(g/day)	5.57±1.5	5.71±1.2	6.05±0.88	5.89±1.1
Urinary N. (g/day)	8.46±0.85	8.81+1.9	8.56±3. 2	10.24+2.5
N. retained (g/day)	10.39±4.9[a]	8.19±2.3a	3.11±1.5[b]	4.50±2.5[b]
Nitrogen retained as % of intake	40.77±9.8[a]	36.19±7.9[a]	17.45±9.6[b]	20.67±6.8[b]
Nitrogen retained as % of digested	53.17±18.4[a]	48.08±9.4[a]	27.15±17.1[b]	28.89±8.9[b]

Values are means of eight animals ± SD.

[ab] Values within the same row bearing different superscript differ significantly at ($P<0.05$).

DISCUSSION

The steady decrease in dry matter intake with increasing molasses levels in the diet was supported by observations of other workers (Wayman, 1954; Lofgreen and Dtagaki, 1960; Pollot- and Ahmed, 1979; Sanchez and Preston, 1980). Total or daily weight gains were positive up to 40% molasses level in the diet then declined with further increase of molasses in the diet (45%). Positive effects were also in experiments' with sheep at 10 and 20% levels (Merino *et al.*, 1965). When series of molasses levels were used (15% up to 60%) in the diet of sheep, the 30% level was shown to give the best weight (Pollot and Ahmed, 1979).

Rumen fermentation pattern did not differ significantly between the different rations. The decrease in rumen ammonia nitrogen (NH_3-N) level 6 hours post-feeding could be related to the increase in total volatile fatty acids (VFAs) which is usually used as a source of energy supply that assisted in the incorporation of NI-1$_3$-N into microbial cells for microbial protein formation with subsequent decrease in NH_3-N level observed after feeding. Furthermore, the high degradability of molasses was well matched with the degradability of other components of the diet, which encouraged microbial multiplication.

Apparent digestibility for the different nutrients could be correlated with the ingredients of each ration. In this context, ether extract level was the highest in ration 1 resulting in high digestion of the lipids. Similar findings were obtained by Balasubramanya *et al.* (1980). Nitrogen free extract digestions were shown to reflect carbohydrate concentrations in the different rations (Table 4). However, the insignificant differences obtained in this study were similar to those observed in sheep given increasing molasses level (0 - 151.1 g/kg toluene DM) (Givens *et al.* 1992). Also, the insignificant differences obtained in both dry matter and organic matter digestions were supported by findings of other workers using different molasses levels in the diets of sheep (Umoh, 1983; Carrasco *et al.* 1993). Crude fiber digestion was suppressed at the 40 or 45% molasses level in the ration, which could be related to the presence of high concentration of soluble sugars accompanied by low fiber content which were known to reduce the activity of cellulolytic bacteria responsible for fiber digestion.

In the present study, sheep rations containing 30 and 35% molasses level showed improved nitrogen retention, which was reflected in increased body weights. However, the highest gain was observed with the 40% level, which could be related to fat deposition as the amount of nitrogen retained at this molasses level was significantly reduced.

It could be concluded that inclusion of molasses at the 30% level was the best economical way for sheep fattening. Although the highest gain was obtained with, the 40% level but that would not be preferred by human consumption due to the high fat content.

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Authors:

Muna Mahgoub Mohamed Ahmed Sara Rasheed

Sid Ahmed Beheri Asim Abd El Razig Lutfi

تأثير المستويات المختلفة من المولاس علي نمط التخمير في الكرش ، معامل الهضم ، ميزان النيتروجين والكسب في الوزن للأغنام (الضأن) الصغيرة

مني محجوب محمد أحمد ، سارة رشيد سيد أحمد بحيري وعاصم عبد الرازق لطفي - معهد الدراسات البيئية . ص.ب. 321 الخرطوم

خص البحث روس بنسب مختلفة (300 ، 35 اعلان 4 عنف خصمت محتوياتها بحيث أجريت هذه تاثير ندا 40 و 45 %) في عليقة الضاي علي تكون متساوية في مستوي النتروجين والطاقة وذلك بإحلال المولاس القشرة الفول السوداني في العليقة الأساسية التي احتوت على ردة الفسح و آسمان الفول السوداني ، أستخدم عند 32 كيش في تجربتي نسمين وهضم حيث وزعت كل أربعة فرق من الكباش بطريقه عشوائية حرة لشفتي كل منها على نوع واحد من إحدى العلائق المعدة ، كان ذلك بالنسبة التجارب التسمي ، أما بالنسية التجاري الهضم لن أخضعت الحيوانات المنصب اللاتيني ربع (4 * 4) حيث أخذت كل الفرق حظها في كل العلائق بطريقة عشوائية أبين النتائج أن المادة الجافة المتداولة تناقصت بطريقة تدريجية كلما زادت نسبة المولاس في مع عدم وجود فروقات معنوية . أما الوزن فزاد بصورة معنوية (P = 05) بالنسبة للحيوانات التي تعذت علي 30 و 40 مو لاس بالرغم من وجود نقص معنوي (P = 0.05) في كمية البروتين المحتجز بالنسبة للمجموعة التي تغنت على (40 مودم مما دل على أن الزيادة في الوان كان مصدرها الزيادة في الشحم المترسب . ازدادت كمية النتروجين المحتجز بصورة معنوية (P < 0.05) بالنسبة للحيوانات التي تفنت حي 30 و 35 عو لاس زد هضم الدهن في العليقة التي بها نسبة سولاس (30 % (05 (0 = P) بينما زاد فضم الألياف الخام (P = 0 05) في العليقة التي احتوت علي 30 و 35 % سولاس ، لحمة في تخمر الكرش وكذلك تركيز البوريا في الدم لم يتغير ان تتغير نسبة المولاس في العليقة ولكن حدث تغير نتيجة لتناول الماء حيث قلت حمضية الكرش وكنت نسبة النتروجين المرتبطة بالأمونيا في الجانب الأخر فقد زانت نسبة الأحماض الدهنية الطيارة لمحتوي الكرش عقب 6 ساعات من تناول الطعام ولكن بدون فروقات معنوية

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