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Effect of Either Once or Twice Daily Feeding of Pelleted High-Concentrate Diet on Performance and Digestion in Growing Lambs

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Abstract: Twenty-four Najdi ram lambs, weighing an average of 24 kg and *circa* 3 months old were utilized in this trial to evaluate the effect of two feeding frequencies on growth performance, carcass characteristics, digestion coefficients, nitrogen retention and ruminal VFA and ammonia-N concentrations. The feeding protocol involved once daily feeding at 0800 h and twice daily feeding in two equal portions at 08:00 and 15:00 h lambs were offered a sufficient quantity of total daily DM (95 g DM day^{-1} w0.75) to resemble *ad libitum* consumption. All lambs were slaughtered after a 14 week feeding trial. Although, the results showed no significant effect of frequency of feeding on DMI, ADG, carcass weight, digestibility of DM, CP and ADF and N-retention, lambs fed one meal daily had higher ($p<0.05$) gain efficiency and NDF digestibility and lower ($p<0.05$) dressing percentage than lambs fed two meals daily. Rumen total VFA concentrations at all post-feeding intervals were not influenced ($p>0.05$) by feeding frequency, except at 10 h post-feeding; rumen VFA concentration value at 10 h post-feeding was higher ($p<0.05$) in lambs fed once daily than those fed twice daily. Feeding once daily resulted in a greater ($p<0.05$) molar proportion of propionate and a smaller ($p<0.05$) molar proportion of acetate than from feeding twice daily. The ruminal fluctuations in total VFA and ammonia-N concentrations were less obvious in the lambs fed twice daily than once daily.

Key words: Feeding frequency, lambs, performance, digestibility, carcass, ruminal fermentation

INTRODUCTION

Since modern sheep farms in Saudi Arabia are likely to depend almost entirely on complete pelleted rations, improvement in feeding efficiency will require increased efforts to investigate the role of diet composition and different possible feeding schedules on animal performance and digestion. Experiments conducted with various classes of ruminants to evaluate the influences of different feeding schedules on intake, digestion and animal performance have yielded conflicting results.

In most of these studies increased daily feeding frequency had not or had only a slight positive effect on the variables studied (Goonewardene *et al*., 1995; Drennan *et al*., 2006; Robles *et al*., 2007; Schutz *et al*., 2007). Feeding schedules in which small meals are offered at more frequent daily intervals tend to have a stabilizing effect upon ruminal fermentation and thereby a more efficient digestion (Yang and Varga, 1989; Shabi *et al*., 1999). Nevertheless, increased frequency of daily feeding may also increase the rate of ingesta removal from the rumen resulting in greater escape of potentially degradable substrate (Robles *et al*., 2007). Whether these reciprocating mechanisms represent a positive or negative shift in digestive efficiency depend upon diet quality, water and DM intakes, animal age and the potential for compensatory digestion in the lower gastrointestinal tract (Bunting *et al*., 1987).

High levels of concentrate feeding in Saudi Arabia may be desirable because of the increasing cost of roughages relative to concentrate feeds. Although, feeding high concentrate diets are beneficial in fattening lambs, limited information is available on the effect of frequency of daily feeding on the utilization of pelleted high-concentrate diets.

Therefore, the objective of the present study was to assess the influence of feeding the same quantity of a pelleted high-concentrate diet either once or twice daily on lamb performance, digestibility and rumen fermentation patterns.

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MATERIALS AND METHODS

Animals and housing: Twenty-four Najdi male weaner lambs, of average body weight 24±0.6 kg and circa 3 months old were used in this experiment. Lambs were purchased from a local farm; upon arrival, lambs were individually weighed, identified, vaccinated, injected against internal and external parasites and vitamin A-D-E injections were given. Thereafter, lambs were assigned randomly to one of two equal groups with twelve lambs in each group. Each group contained four replicates (pens) with three lambs per pen; pen was used as the experimental unit for feed performance data. Pens were 1.7×3.0 m and constructed of metal gates and concrete floors and were located under a roof in an open-sided barn.

Feeding trial: The experimental diet (Table 1) was prepared as a pelleted total-mixed ration with a ratio of 75% concentrate: 25% alfalfa hay (DM basis); the dietary concentrate ingredients were ground through a 4.76 mm screen, whereas the alfalfa hay was ground to pass through, a chopper machine equipped with 9.5 mm screen. All dietary ingredients were then mixed thoroughly in stainless steel vertical mixer; the mixed ingredients were put directly into the pelleting unit in front of the hammer mill. Steam was used to enhance the process of pelleting. Diet was formulated to meet daily energy and protein requirements.

Animal groups were randomly allotted to two dietary treatments to evaluate the effects of feeding the same quantity of diet either once or twice daily on growth performance, nutrient digestibility, nitrogen balance, carcass characteristics and ruminal VFA and ammonia-N concentrations. Lambs were offered a sufficient quantity of daily feed (95 g DM/day/$w^{0.75}$) to resemble *ad libitum* consumption with 5% refusals. The feeding protocol involved once daily feeding at 08:00 h and twice daily feeding in two equal portions at 08:00 and 15:00 h resembling two feeding frequencies. Daily refusals were removed, weighed, sampled for DM determination and then discarded. Feed samples were collected weekly for DM determination and 4 weeks samples were pooled for chemical analysis. The feeding trial lasted for 14 weeks during which DM consumption and lamb weight data were recorded weekly; lamb weight was recorded after 12 h without feed. Fresh drinking water was available at all times.

Carcass measurements: At the end of the feeding trial, all lambs were slaughtered after 12 h without feed. At slaughter, the live body weight, hot carcass weight and dressing percentage were recorded. Then, the 9-11th rib joint was separated from the right side of each carcass and physically separated into bone, fat and lean. The lean tissues were ground through a 4 mm plate, mixed and reground again. During the second grinding, 5 subsamples (10-12 g) were taken from each carcass to form a 50-60 g sample that was placed in a plastic bag, frozen and stored at -20°C pending chemical analysis.

Table 1: Ingredients and chemical composition of the experimental diet

Ingredients	DM (%)
Alfalfa hay	25.00
Barley	59.44
Wheat bran	7.50
Soybean meal	2.94
Salt	0.38
Limestone	1.73
Acid buf[1]	0.38
Molasses	2.25
Lignobond[2]	0.23
Trace minerals and vitamin[3]	0.15
ME Mcal kg^{-1} DM[4]	2.78
Chemical composition	
DM	95.68
CP	14.53
EE	1.16
ADF	24.91
NDF	14.22
Ash	7.46

[1]Natural buffer derived from seaweed (CelticSea Company, Ireland); [2]Calcium lignosulfate as pellet binder; [3]Contained 10,000 (IU kg^{-1}) vitamin A, 1000 (IU kg^{-1}) vitamin D, 20 (IU kg^{-1}) vitamin E, 300 mg kg^{-1} of Mg, 24 mg kg^{-1} of Cu, 0.6 mg kg^{-1} of Co, 1.2 mg kg^{-1} of I, 60 mg kg^{-1} of Mn, 0.3 mg kg^{-1} of Se, 60 mg kg^{-1} of Zn, of finished feed; [4]Tabulated

Apparent digestibility and nitrogen balance: A digestibility trial was started on day 90 of the feeding trial on eight lambs to determine digestibility coefficients and nitrogen balance of each feeding schedule. Lambs were randomly selected and withdrawn from the feeding trial at the rate of one lamb per replicate. The digestibility trial lasted for 8 days (i.e., 3 days adaptation followed by 5 days of sample collection) during which daily feed intake and output of feces and urine were collected and recorded. Lambs were individually confined in false bottom metabolic crates to facilitate separate collection of total feces and urine. Total feces voided were collected, weighed and a 10% aliquot was dried at 65°C for 24 h. The dried samples were ground through a 1 mm screen and stored for later analyses. Total daily urine output of each lamb was collected in a plastic bucket containing 100 mL 6 N HCl to prevent nitrogen losses, recorded and a 10% aliquot was sampled; at the end of the collection period, samples of urine from each lamb were mixed for nitrogen determination.

Ruminal fermentation: Rumen liquor samples were collected once on day 90 of the feeding trial from four

randomly selected lambs from each treatment group. Samples (50 mL) were withdrawn at 3, 7, 10, 14 and 24 h post-feeding using a stomach tube. Each sample was strained with muslin cloth, placed in a glass jar and stored at -20°C for Volatile Fatty Acids (VFA) and ammonia-N determinations. VFAs were measured by gas chromatography (model 404, Philips). Ammonia-N was determined by the distillation method using MgO.

Chemical and statistical analysis: Samples of the experimental diet, feces, urine and ground lean tissues were analyzed for DM, ash, ether extract and crude protein. NDF and ADF were determined according to Van Soest *et al.* (1991). Data for growth performance, carcass characteristics, chemical composition, apparent digestibility coefficients and ruminal VFA and ammonia-N concentrations were statistically analyzed by ANOVA using general linear model procedures. Duncan's multiple range test was used to test for significant differences between means. A significance level of 5% was used to express statistical difference between means.

RESULTS AND DISCUSSION

Growth performance: The effects of feeding frequency on performance and carcass traits are shown in Table 2. Live body weight after 14 weeks in feeding trial and ADG were unaffected ($p>0.05$) by either once or twice daily feeding. Similar results were reported by Goonewardene *et al.* (1995) and Schutz *et al.* (2007), who noted that frequency of daily feeding had no effect on ADG in animals. Cecava *et al.* (1990) suggested that effects of feeding frequency are related to the nature of the diets fed and the level of DM intake and that these effects may be less pronounced at similar or lower levels of intake. In the present study, the same quantity of pelleted high-concentrate diet was offered daily to each group of lambs; correspondingly, feed refusals were almost negligible throughout the feeding trial, resulting in average DM intakes of 3.76 and 3.74% of live weight for once a day and twice daily feeding regimens, respectively. Therefore, the lack of effect of feeding frequency on ADG in the present trial was in accordance with the lack of changes in daily DM intakes between once and twice daily feeding. Also, Clark and Keener (1962) suggested that the change from once a day feeding routine to several times a day leads to a positive temporary response in performance which may last for a few weeks, after which the animals' adjustment to the new routine is completed and a response no longer accrues. Feed to gain ratio was improved ($p<0.05$) in lambs fed once daily as compared with twice daily feeding. However, this result contrasts with the findings compiled by several researchers where improvements in body weight gain and feed efficiency were observed with increased feeding frequency in growing ruminants. They concluded that, growth responses obtained could be largely attributed to increased food intake (Putnam *et al.*, 1961), increased total body water (Faichney, 1968) or increased total-tract DM digestibility (Shabi *et al.*, 1999). The latter investigators attributed the positive effects of increased meal frequency to a more stable rumen environment and thereby a more efficient digestion and daily gain.

Table 2: Effect of feeding frequency on growth performance and carcass characteristics in Najdi lambs

	Feeding frequency		
Traits	Once daily	Twice daily	SEM
Performance			
Initial body weight (kg)	23.9	23.8	0.45
Final body weight (kg)	49.9	48.3	1.23
Average daily gain (g)	265	250	12.55
Dry matter intake (g)	1388	1351	20.33
Feed: gain ratio (g g^{-1})	5.24[a]	5.40[b]	0.09
Carcass traits			
Carcass weight (kg)	24.2	24.6	0.65
Dressing (%)	48.5[b]	50.9[a]	1.88
Separable lean[1]	44.5	44.0	1.23
Separable fat[1]	35.1	35.8	0.88
Chemical composition[2]			
Moisture (%)	67.5	66.8	2.84
Protein (%)	18.8	18.3	1.01
Ether extract (%)	12.7[b]	14.0[a]	0.67
Ash (%)	1.0	0.9	0.06

[a,b]Means in the same row bearing different superscripts differ ($p<0.05$); [1]Determined by physical separation of 9-11th rib joint. [2]Chemical analyses of separable lean from 9-11th rib joint

Carcass characteristics: Except for dressing percent, there was no effect ($p>0.05$) of feeding frequency on carcass traits; altogether, the numerically increased body weight and decreased carcass weight with once a day feeding resulted in a significantly ($p<0.05$) decreased dressing percent. This result may partially due to increased weight of gastrointestinal tissues to cope with larger meal size in those lambs fed a similar weight in one instead of in two daily meals. Early studies have shown that feeding animals less frequently can result in increased weights of the gastrointestinal tissues (Allee *et al.* (1972) for pigs; Pocknee and Heaton (1976) for rats). Similarly, Walker *et al.* (1967) showed that the weight of the abomasums increased 41% when lambs were fed a similar amount in 2 instead of in 6 meals. Also, the similar carcass weight between once and twice daily feeding is consistent with the study of Drennan *et al.* (2006). Feeding lambs once a day was anticipated to result in decreased ($p<0.05$) ether extract percent, which means that less energy was deposited as intramuscular fat in the separable lean from 9-11th rib joint. However, it seems

possible that the increased energy expenditure needed to maintain heavier gastrointestinal tissues may partly explain the lower percent of deposited intramuscular fat when lambs were fed one daily meal. Similar results were reported by Van den Borne *et al.* (2006) who found that gastrointestinal hypertrophy with decreasing frequency of feeding in calves contributes to increased energy requirements because portal-drained viscera account for a large amount of heat production. On the other hand, the decreased intramuscular fat deposition in less frequently fed lambs contrasts with studies in human and monogastric animals in which eating less frequently decreased physical activity and activity related heat production and consequently either increased or did not affect body adiposity (Bellisle, 2004).

Digestibility coefficient: The effects of feeding frequency on total tract nutrient digestibility and nitrogen balance are shown in Table 3. Apparent total tract digestibility of DM, CP and ADF were not affected ($p>0.05$) by feeding the lambs once or twice daily. The non-significant difference between the feeding frequencies is consistent with the results reported in literature for DM (Drennan *et al.*, 2006) and CP digestibility (Faichney, 1968). In contrast to the former findings, Campbell and Merilan (1961) and Shabi *et al.* (1999) reported that DM and CP digestibility were lower when animals fed the daily ration as a single meal than if the ration were fed in two or more portions during the day, whereas Bunting *et al.* (1987) observed that apparent CP digestibility decreased with increasing meal frequency. There was a significant difference ($p<0.05$) for apparent total tract digestibility of NDF, as NDF digestibility decreased in Najdi lambs fed pelleted high-concentrate TMR diet twice daily in comparison with those fed once daily. In the present trial, frequent feeding may increased daily water consumption (Robles *et al.*, 2007) and subsequently, the escape of potentially degradable fiber substrate from the rumen, possibly resulted in a depression in NDF digestion. Bunting *et al.* (1987) and Cecava *et al.* (1990) found similar result that the percentage of NDF intake digested tended to be lower for feeding frequencies beyond once daily. In contrast to the finding, Shabi *et al.* (1999) and Dhiman *et al.* (2002) stated that increased feeding frequency was associated with an increase in total tract NDF digestibility; this improvement might be attributed to reduced diurnal fluctuations in ruminal pH and thereby a more efficient fiber digestion by avoiding the negative effects of low pH on attachment of cellulolytic bacteria to fiber particles (Hoover, 1986). On the other hand, Ulyatt *et al.* (1984) concluded that neither the extent nor primary sites of digestion of cell wall components were affected by increasing the frequency of feeding from one to 24 times daily in sheep fed alfalfa hay diet.

Table 3: Effect of feeding frequency on mean apparent digestibility coefficients (%) and nitrogen utilization in Najdi lambs

	Feeding frequency		
Traits	Once daily	Twice daily	SEM
Digestibility coefficients (%)			
DM	76.7	75.5	1.61
CP	83.1	83.7	1.04
ADF	47.6	48.5	2.40
NDF	50.9[a]	47.3[b]	1.89
Nitrogen balance			
N intake (g day^{-1})	29.0	28.4	1.35
Fecal N excretion (g day^{-1})	4.6	4.7	1.04
Urinary N excretion (g day^{-1})	6.2	6.3	0.94
N-retained (intake %)	62.8	61.3	3.44

[a,b]Means in the same row bearing different superscripts differ ($p<0.05$)

As with apparent CP digestion, feeding lambs once-or twice-daily did not result in changes in any of the nitrogen utilization parameters (Table 3), neither N-excretion nor N retention were affected ($p>0.05$) by meal frequency, in agreement with the results of Faichney (1968) and Bunting *et al.* (1987) but contrary to the findings of Satter and Baumgardt (1962). Rakes *et al.* (1961) found that lambs excreted approximately 20% less nitrogen in the urine when they were fed 8 times per day than when fed only once daily; frequency of feeding, however did not produce this effect in mature sheep. They concluded that mature ruminant might have a greater ability than the young growing ruminant to recycle and use some of the urea formed from the excess ammonia absorbed from the rumen. The latter conclusion does not appear to explain the present results in view of the fact that this trial was carried out with feeder lambs all presumably still in the process of growing. In conclusion, reasons for the discrepancy in nutrients digestibility and utilization between the study and other data reported in the literature are unclear but can be speculated on as due to a combination of characteristics pertaining to animals and feeds.

Rumen fermentation: The effect of feeding frequency on total VFA concentrations in the ruminal liquor of growing Najdi lambs are shown in Table 4. Rumen total VFA concentrations at all post-feeding times were not influenced ($p>0.05$) by feeding frequency, except at 10 h post-feeding; rumen VFA concentration value at 10 h post-feeding was higher ($p<0.05$) in lambs fed once daily than those fed twice daily. When total VFA concentration measures post-feeding were averaged across time (Pitt and Pell, 1997), the effect of frequency of feed was obvious, indicating that average total VFA concentration in lambs fed one meal daily were higher ($p<0.05$) than

Table 4: Effect of feeding frequency on total and individual Volatile Fatty Acids (VFA) concentrations in the rumen liquor of growing Najdi lambs at different time post-feeding

	Feeding frequency		
Post-feeding time (h)	Once daily	Twice daily	SEM
Total VFA (mM)			
3	45.7^{B}	44.1^{A}	3.66
7	49.7^{B}	46.9^{A}	4.06
10	74.2^{aA}	45.5^{bA}	3.22
14	31.0^{C}	39.3^{A}	3.10
24	27.3^{C}	24.6^{B}	3.19
Average[1]	44.3^{a}	38.0^{b}	4.01
SEM	4.78	5.20	
mol/100 mol total VFA[1]			
Acetate (A)	38.5^{b}	41.1^{a}	3.46
Propionate (P)	42.1^{a}	39.1^{b}	3.18
Butyrate	10.9	10.5	1.88
A:P ratio	0.91^{b}	1.05^{a}	0.11

[1]Calculated as area under VFA concentrations versus time curve, divided by total time period. $^{a, b}$Means in the same row bearing different superscripts differ ($p<0.05$). $^{A-C}$Means in the same column bearing different superscripts differ ($p<0.05$)

lambs fed two meals daily (44.3 vs. 38.0 mM). The greater VFA concentration may have resulted, in part from the increased NDF digestion in those lambs fed one-daily meal. Also, increasing meal frequency might reduce ruminal VFA production or, alternatively, increased the rate of VFA absorption from the rumen. An additional factor that might have contributed to observed difference in response to feeding regimen was that increasing frequency of feeding probably resulted in increases in water consumption and changes in ruminal fluid dilution rate may have altered ruminal VFA concentrations. However, this finding agrees with results presented by Bunting *et al.* (1987) and Soto-Navarro *et al.* (2000) who reported that feeding a high concentrate diet twice daily decreased ruminal VFA concentration compared with feeding once daily. In contrast, Cecava *et al.* (1990), Shabi *et al.* (1999), Drennan *et al.* (2006) and Robles *et al.* (2007) found that total VFA concentration was not affected by feeding frequency, whereas Knox and Ward (1961) stated that total VFA concentration increased significantly when the feeding frequency increased from two to 8 times per day in dairy heifers.

Total VFA concentration in the ruminal liquor from lambs fed once or twice daily was affected ($p<0.05$) by hour of post-feeding. The concentration of total VFA from lambs fed one meal daily increased gradually ($p<0.05$) to attain its peak value at 10 h post-feeding before subsequently decreasing ($p<0.05$) to the original concentration at 0/24 h post-feeding (Table 4). Different pattern of changes was observed for lambs fed twice daily where the total VFA concentration increased ($p<0.05$) to reach its maximum after 3 h of feeding and remained stable for the next 11 h (14 h post-feeding) before declining ($p<0.05$) to the original concentration at 0/24 h post-feeding; rumen VFA concentration at 24 h post-feeding resembles the original concentration at 0 h post-feeding. Knox and Ward (1961) reported that dairy heifers fed twice daily showed two distinct peaks both within 1-2 h after feeding, which dropped to the lowest point the hour before the next feeding. Moreover, Soto-Navarro *et al.* (2000) found that total VFA concentration in steers fed once daily was the greatest after 9 h of feeding, whereas feeding twice daily resulted in two VFA peaks at 3 and 12 h post-feeding. Presumably, lambs fed once daily had a greater VFA concentration at 10 h post-feeding because the quantity of DM consumed in one meal was greater than in lambs fed twice daily (74.2 vs. 45.5 mM). Lambs fed twice daily presumably reached a fermentation peak earlier (3 h post-feeding) because less feed was consumed at the morning meal. Also, it is noticeable that the ruminal fluctuations in total VFA concentration were less obvious in the lambs fed twice daily than once daily. This finding was probably due to the lambs which fed two meals daily had their DM intake and thereby ruminal fermentation more evenly spread over a longer period of time during the day than those fed once daily. Therefore, a steady input of nutrients into the rumen over the course of the day would stabilize ruminal VFA production. This conclusion is in agreement with Bragg *et al.* (1986) and Yang and Varga (1989), who found that increased frequency of feeding stabilized diurnal fluctuation of ruminal fermentation patterns and minimized variation in VFA production.

The effect of feeding frequency on individual VFA proportions in the rumen liquor, averaged across the five sampling periods, are presented in Table 4. Acetate molar proportion was less ($p<0.05$) in lambs fed once daily compared with lambs fed twice daily. In contrast, feeding once daily resulted in a greater molar proportion of propionate than from feeding twice daily. Acetate: propionate ratio was lower in lambs fed once versus twice daily. Similarly, Bunting *et al.* (1987) and Soto-Navarro *et al.* (2000) reported that increasing feeding frequency increased the molar proportion of acetate and decreased the molar proportion of propionate however, this response was attributed primarily to attenuation of ruminal pH changes, which resulted in greater populations and activity of ciliate protozoa and cellulolytic bacteria. On the other hand, several studies reported that frequency of feeding had no effect on the concentration of the individual VFA in the ruminal ingesta (Faichney, 1968; Cecava *et al.*, 1990; Robles *et al.*, 2007). An increase ($p<0.05$) in acetate:propionate ratio and a reduction in average total VFA concentration ($p<0.05$)

with twice-daily feeding might explain the reduction in ADG ($p>0.05$) and feed:gain ratio ($p<0.05$) in the present trial because the acetic is utilized less efficiently than propionic. Additional evidence for the involvement of acid ratios in production efficiency was provided by the research of Elliott and Loosli (1959).

The effect of feeding frequency on ammonia-N concentrations in the ruminal liquor are presented in Table 5. Feeding lambs twice daily increased ($p<0.05$) ruminal NH_3-N concentrations. This may have been the result of greater recycling of blood urea-N into the rumen of lambs fed twice daily. Similarly, Robles *et al.* (2007) found marked increases in ruminal NH_3-N concentrations as frequency of feeding increased. By contrast, Ulyatt *et al.* (1984) and Bunting *et al.* (1987) observed decreases in mean ruminal NH_3-N concentrations in sheep as feeding frequency increased. Frequency of feeding had significant ($p<0.05$) effect on minimum and maximum NH_3-N concentrations attained during a 24 h feeding cycle however, the pattern in ruminal NH_3-N concentration differed between once and twice-daily fed lambs. The greatest ($p<0.05$) ruminal NH_3-N concentrations were found at 10 h post-feeding in one- and two-times feeding regimen.

Subsequently, the ruminal NH_3-N concentrations from once-daily fed lambs dropped ($p<0.05$) gradually, attaining its minimum concentration at 24 h post-feeding, whereas in twice-daily fed lambs remained unchanged ($p>0.05$) up to the end of 24 h feeding cycle, attaining its minimum at 3 h after the first feeding. The more stable ruminal conditions observed when lambs were fed a high-concentrate diet twice daily compared with once daily, as indicated by lower maximum and higher minimum NH_3-N concentrations are in accordance with results obtained by Yang and Varga (1989) and Robles *et al.* (2007).

This observation associated with high-concentrate feeding frequency has seldom been reported previously in growing lambs and presumably it may have been a result of the variable quantities of feed consumed by those lambs at each meal.

Similar conclusions were reported by Bragg *et al.* (1986) and Yang and Varga (1989), who noted that diurnal variation in rumen NH_3-N concentration in animals were strongly influenced by the amount of concentrate consumed per meal and increased frequent feeding of concentrate increased rumen ammonia-N concentrations. Further, Burt and Dunton (1967) reported that more uniform concentration of NH_3-N in rumen fluid would be expected to increase ammonia-N concentration by reducing losses through absorption.

Table 5: Effect of feeding frequency on ammonia-N concentrations in the rumen liquor of growing Najdi lambs at different time post-feeding

	Feeding frequency		
Post-feeding time (h)	Once daily	Twice daily	SEM
NH_3-N mg/100 mL			
3	9.8^{B}	10.8^{C}	2.04
7	9.7^{bB}	12.8^{aBC}	2.18
10	12.5^{bA}	15.2^{aA}	3.61
14	9.6^{bB}	15.5^{aA}	3.48
24	7.7^{bC}	14.8^{aAB}	3.62
Average[1]	9.6^{b}	14.2^{a}	4.05
SEM	2.12	1.98	

[1]Calculated as area under NH_3-N concentrations versus time curve, divided by total time period. [a, b]Means in the same row bearing different superscripts differ ($p<0.05$). [A-C]Means in the same column bearing different superscripts differ ($p<0.05$)

CONCLUSION

Results indicate that there is no advantage for feeding a pelleted high-concentrate diet more frequently than once daily either from the standpoint of body gain or diet digestibility. Although, feeding lambs twice daily seems to stabilize the ruminal environment, a reduction in ruminal VFA concentration and an increase in the acetate: propionate ratio were detected, which resulted in lower efficiency of food utilization as compared with once daily feeding. The consequences of this are positive for sheep producers due to the opportunity to reduce feeding and labor and equipment operation costs.

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