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Dept. of Animal Production,
Faculty of Agriculture, Assiut University,

GROWTH PERFORMANCE AND SOME BLOOD PARAMETERS IN LAMBS DURING FATTENING PERIOD AS AFFECTED BY FEED FREQUENCIES OF EITHER *AD LIBITUM* OR RESTRICTED SYSTEMS

(With 8 Tables)

By
M.N. ABD EL-ATI; S.F ABBAS, F.F., EL-HOMMOSI and A. M. ABD ALLAH

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كفاءة النمو وبعض مقاييس الدم خلال فترة التسمين والمغذاه على فترات متعددة بنظام التغذية حتى الشبع أو المقننه فى الحملان.

محمد نصرت عبد العاطى ، سيف اليزل عباس ، فيصل فرحات الحمصى ، محمد أحمد عبد الله

تم إجراء تجربتين لتقييم تأثير عدد مرات التغذية سواء بإستعمال نظامى التغذية حتى الشبع أو التغذية المقننه على أداء الحملان فى النمو وبعض مقاييس الدم. وتم إستخدام ٢٤ و ١٥ حمل أوسيمى بمتوسط وزن الجسم ٥٠ و٥١ كجم على التوالى. وفى كل تجربة غذيت الحملان مره أو مرتين أو ثلاثة يومياً. ونم وزن الحملان إسبوعياً وسجلت كمية الغذاء المتناول والماء يومياً. وفىكلاً من نظامى التغذية زاد الغذاء والماء المتناول والعائد اليومى فى وزن الجسم بزيادة عدد فترات التغذية. ولكن الحملان التى غذيت أكثر من فتره يومياً فى نظام التغذية حتى الشبع تناولت ماء وغذاء أكثر عن مثيلاتها فى نظام التغذية المقننه. وكانت الحملان المغذاه أكثر من فتره أكفأ فى تحويل الغذاء لزيادة فى الوزن اليومى فى كلا نظامى التغذية حتى الشبع والمقننه بينما كانت الحملان فى نظام التغذية المقننه أكثر كفاءة فى تحويل الغذاء للزيادة اليومية عن قريناتها المغذاه حتى الشبع عند تعدد مرات التغذية. كان المتوسط العام لتركيز الجلوكوز ونيتروجين اليوريا أعلى فى الحملان عديدة فترات التغذية سواء المغذاة حتى الشبع او المقننة التغذية. بينما فى الحملان العديدة فترات التغذية ومغذاة حتى الشبع كانت أعلى فى تركيز كلاً من الجلوكوز ونيتروجين اليوريا عن تلك المقننة التغذيه .

SUMMARY

This experiment evaluated the effect of feed frequencies of either *ad libitum* or restricted systems on growth performance and some blood parameters in lambs. Twenty four and fifteen Ossimi lambs of 50 and 51 kg live weight were subjected to *ad libitum and* restricted *feeding* treatments, respectively. In each treatment, the three groups of lambs were fed once, twice or thrice / day. Lambs were weighed weekly as well as feed intake and water consumption were recorded daily. In both feed frequency trails (*ad libitum* and restricted), feed intake, water consumption and daily gain increased with increasing feed frequency. But lambs fed more frequent feeding under *ad libitum* level consumed more water and feed intake than those fed frequent feeding under restricted. Lambs fed more frequent feeding was efficient in converting feed to gain under restricted or *ad libitum* levels, but lambs fed more frequent feeding under restricted level were more efficient in converting feed to gain than those fed more frequent feeding under *ad libitum* level. Lambs fed more frequent feeding had higher overall mean of glucose and urea concentration under *ad libitum* or restricted levels, but lambs fed frequent feeding under *ad libitum* level had higher mean glucose and urea concentration than those under restricted feeding

Key words: *Lambs, Feed frequency, Growth performance.*

INTRODUCTION

Feeding pattern is defined as the distribution of feed intake over time. Michalowski and Muszynski (1978) found that feeding is available all of the time or it may be offered at some periods of the day, while Velasco *et al.* (1999) reported that feeding frequency and the amount per feeding are an integral part of feed management.

Carter *et al.* (1990) reported that feed intake improved with increasing feed frequency of sheep, while Bunting *et al.* (1987) showed water intake increased with increasing feed frequency in ruminant. Mochrie (1964) and Ikhatuta *et al.* (1987) reported that increasing feed frequency more than once or twice per day improved the live weight gain of growing ruminants. Also, Rakes *et al.* (1961) showed that live weight gain increased when feeding frequency was increased from once to eight times per day in lambs. Ikhatuta *et al.* (1987) revealed that average live

weight gain was significantly improved ($P<0.05$) as the feed frequency increased from once to twice per day and from twice to three times per day in growing bulls.

In the sequence of improving feed intake, water intake and daily gain increased by increasing feed frequency, also feed conversion was improved (Ikhatuta *et al.*, 1987). Meanwhile, Abdel-Rahman and Suliman (1994) found that lambs fed four or eight times per day were more efficient in converting feed into weight gain than those fed once per day. But Carmley *et al.* (1991) reported no significant effect on feed intake during the *ad libitum* or restricted feeding in wether sheep fed twice or eight times per day. Also Ruiz (1989) concluded that feed intake of calves was not significantly affected by number of either once or four times daily feeding treatment.

Also, some blood parameters were changed as a result of increasing feed frequency, where , Mineo *et al.* (1990) reported that average daily plasma glucose increased with increasing feeding frequency from one to two or from one to five times of feeding per day.

The aim of this study was to determine the effect of feed frequencies of either *ad libitum* or restricted systems on growth performance and some blood parameters in lambs during fattening period under Upper Egypt conditions.

MATERIALS and METHODS

The present study was carried out at the Animal Experimental farm, Animal and Poultry Production Department, Faculty of Agriculture, Assiut University. This study was conducted to compared *ad libitum* and restricted feeding regimes in group housing system.

Animals and management: Thirty nine Ossimi lambs of approximately 12 months of age were used. Twenty four Ossimi (50 kg live weight) and fifteen lambs (51 kg live weight) were used in the first and second experiments. In both experiments, lambs were randomly divided into three groups with equal body weight; the first group was fed one time per day at 08.00 hr (once); the second group was fed two times (equal meal amounts) per day at 08.00 and 14.00 hr (twice) and the third group was fed three equal amounts of meal and were offered at 08.00, 12.00 and 16.00 hr (thrice) throughout the experiment period (9 weeks). Lambs in the first experiment were fed bean straw and concentrates mixture on *ad libitum* regime basis applying the frequency of feeding

system. In the second experiment, lambs were fed 20% bean straw and 80% concentrates mixture on restricted feeding regime basis according to NRC (1985) with applying equation:

$$ME \text{ (starch value)} = 112 \times W^{0.75} (1+5.5 \times \text{daily gain}) / 3761.$$

In both experiments, fresh water and mineralized salt blocks were freely available all times. The composition of concentrates mixture is shown in Table (1) and the chemical analysis of concentrates mixture and bean straw are shown in Table (2).

Table 1: The composition of concentrates mixture.

Ingredient	%
Wheat bran	30%
Maize	42%
Decorticated cotton meal	25%
Limestone	2%
Sodium chloride	1%

Table 2: Chemical composition of concentrate diet and bean straw on dry matter basis.

Items	Concentrates mixture	Bran straw
Crude protein	17.89	4.95
Crude fat	1.08	2.23
Nitrogen free extract	57.54	37.87
Crude fiber	8.21	45.83
Ash	15.28	9.12

Growth performance:

In both experiments, lambs were weighed, after fasting period of 14 hr., at the begging of the experiment and thereafter weekly before morning feeding. Feed intake and water intake were recorded daily throughout the experimental period. Live weight gain and feed conversion values were calculated.

Blood sampling:

In both studies, blood samples were collected from Jugular vein just before morning feeding biweekly by using heparinized tubes. Plasma was separated by centrifugation at 3000 r.p.m. for 15 minutes and stored at -20C° until subsequent analysis. Glucose was determined

using kit supplied by Biocon Diagnostics, while Urea nitrogen was determined using kit supplied by Diamond Diagnostics.

Statistical analysis:

In both two experiments, data were statistically analyzed using the general linear model (GLM) procedure of SAS (1996). For growth performance and blood profiles, the following model was fitted :-

$$Y_{ij} = \mu + T_I + E_{ij}$$

Where; **Yij** = the observation.

μ = General mean.

Ti = effect of feed frequency treatment.

E_{ij} = the error related to individual observation.

RESULTS and DISCUSSION

Experiment 1:

Animal performance: Frequency of feeding had a significant ($P<0.05$) effect on concentrate mixture and dry matter intakes (Table 3). Lambs fed twice or three times per day consumed more concentrate mixture, dry matter and water than those fed once per day. In fact, the increase in feed intake, since concentrates were usually consumed rapidly after they were offered, and so, splitting the concentrates allowance in two or three meals per day may have stimulated intake simply by altering the pattern of consumption (Chestnutt and Wylie, 1995). Similarly, feed frequency stimulate feed intake in Dairy cows (Robinson and Sniffen, 1985) and Beef cattle (Beaty *et al.*, 1994).

Table 3: Effect of feed frequency in ad libitum treatment on feed intake, water intake, live weight and gain of lambs (mean ± SE).

Trait	Frequency of feeding/ day		
	Once	Twice	Thrice
Bean straw (kg)	1.75 ±0.06	1.89 ±0.11	1.60±0.06
Concentrates mixture (kg)	10.03±0.38^{c}	11.01±0.33^{b}	12.34±2.34^{a}
Dry matter (kg)	10.76±0.32^{b}	11.78±0.33^{a}	12.67±0.31^{a}
Water intake (kg)	34.68±1.29^{c}	43.40±1.13^{b}	47.80±2.33^{a}
Final body weight(kg)	56.28±2.13^{b}	58.00±2.87^{b}	62.42±2.98^{a}
Total gain (kg)	5.90±0.80^{b}	7.65±1.56^{b}	12.08±1.68^{a}
Average daily gain (g)	93.67±0.01^{c}	121.43±0.01^{b}	191.58±0.01^{a}
Feed: gain ratio (kg/kg)	15.14±1.49^{a}	12.60±0.87^{ab}	8.39±0.36^{b}

$^{a, b, c}$ Means in the same rows with different superscripts differ ($P<0.05$).

Increasing water consumption with increasing feed frequency may be due to increase concentrate mixture intake. Similar results were reported by Bunting *et al.* (1987) who found that lambs increased their water intake by 30% as feed frequency increased from two to 16 times per day. Also, Ulyatt et al. (1984) founf that sheep consumed more water by 35% when feed frequency increased from two to 24 times per day.

The data in Table (3) revealed that final body weight, total gain and average daily gain were significantly affected by the feeding frequency, where, final body weight of lambs fed three times per day was significantly ($P<0.05$) heavier than those lambs fed once or twice per day (62.42 vs. 56.28 and 58.00 kg, respectively). Similarly, total gain of lambs fed thrice per day was significantly ($P<0.05$) higher than those lambs fed once or twice per day (12.08 vs. 5.90 and 7.65 kg, respectively,). Average daily gain was significantly improved ($P<0.05$) as the feed frequency was increased from one to twice by 29.63% and from once to three times per day by 104.52%.

The present study demonstrated that, lambs fed twice or three times per day improved growth rate. Similar results were obtained by Abd-Elrahman and Suliman (1994) who recorded that lambs fed eight or four times had higher daily gain than those fed once daily. Similarly, Chestnutt and Wylie (1995) found that ewes fed three or two times grew rapidly than those fed once per day. Hunt *et al* (1989) found that daily gain increased with increasing feed frequency in steers.

This improvement may be a result of increasing feed intake by lambs fed more than once per day (twice or three times per day). In this respect, Faichney (1968) suggested that improved body weight by increasing feed frequency may be due to decrease in the heat increment with increasing feed frequency.

Feed to gain ratios as dry matter was significantly ($P<0.05$) affected by number of daily feeding (Table 3). Feeding efficiency was significantly improved as the feeding frequency increased from once to three times per day by 45.5% as dry matter to gain . These results are in agreement with those reported by Abdel-Rahman and Suliman (1994) that lambs fed four or eight times per day were more efficient in converting feed into weight gain than those fed once per day.

The improvement of feed efficiency by feeding frequency may be due to higher growth rate in lambs fed three times per day than those lambs fed once per day and/or higher propionate concentration in rumen associated with more frequent feeding (Moir and Somers, 1957; Rakes *et*

al., 1961; Satter and Baumgardt, 1962;), propionate is a major source of glucose (Riis, 1983). Higher blood glucose increased plasma insulin concentration (Hadly, 1984) and/or different body component (Kobeisy, 1994). The end result is the increase of feed conversion ratios.

The improved growth rate and feed: gain ratio as a result of increased feeding frequency has been partly attributed to increased feed intake of lambs (Coleman and Wyatt, 1982; Sniffen and Robinson, 1984). The degree to which growth rate and feed efficiency are altered depends on some factors such as feed restriction (Carmley *et al.*, 1991; Ruiz and Mowat, 1987) and feed quality (Bunting *et al.*, 1987).

Some blood parameters.. The effect of feeding frequency under *ad libiutm* feeding system on glucose concentration are shown in Table 4. In the second week of treatment there was no significant ($P>0.05$) differences in glucose concentrations for lambs fed once or twice and three times per day.

Also, there was no significant differences in glucose concentrations between lambs fed once and twice per day in week 4 but in week 8 of treatment period, lambs fed once per day had lower ($P<0.01$) plasma glucose concentration than those fed twice or thrice per day.

Moreover, lambs fed three times per day had higher ($P<0.05$) glucose concentration than those fed once per day in the fourth, sixth and eighth week of feeding treatment (Table 4)

Lambs fed three times per day had higher ($P<0.05$) overall mean of glucose concentration than those fed once or twice per day. High glucose concentration of lambs due to more frequent feeding may be attributed to that high readily digested carbohydrates, such as starch, will increase the rate of microbial fermentation, and this is frequently accompanied by a decline in ruminal pH (Jensen and Wolstrub, 1977; Kaufmann, 1976). A reduction in ruminal pH can depress the activity of celluloytic bacteria, whereas the growth of amylolytic bacteria is enhanced (Mackie *et al.*, 1978). This can resulted in increasing propionate production. Propionate production is a major source of glucose concentration (Riss, 1983). Similarly, Mineo *et al.* (1990) reported that daily plasma glucose concentration increased by more frequent feeding in this experiment with sheep fed once, twice or fifth per day.

There was a significant ($P<0.05$) difference in urea nitrogen concentration throughout the experimental period between lambs fed

once and twice per day. However, lambs fed three times had higher blood urea nitrogen concentration than those lambs fed once per day in the 2 nd, 6th and 8th week (Table 5).

Generally, blood urea nitrogen concentration significantly ($P<0.05$) increased as feeding frequency increased. This may be due to that more frequent feeding increase ruminal ammonia levels (Yang and Varga, 1989 Similarly, Clinet *et al.* (1998) reported that concentration of urea nitrogen was greater in mature ewes fed soybean meal once every 24 hr than those fed once every 72 hr. Similar results were found in Dairy cows by Thomas and Morag (1976) who observed that the average concentration of blood urea was lower ($P<0.05$) in Ayrshire cows fed continually than those fed twice daily.

Table 4: Effect of feed frequency under *ad libitum* feeding on urea nitrogen concentration (mg/100ml) of lambs (mean ±SE).

Weeks of feeding frequency	Feeding frequency (time/day)		
	Once	Twice	Thrice
At the beginning	39.70±1.03	39.42±1.03	39.51±1.03
2nd week	40.07±1.03^{b}	42.32±1.03^{b}	45.13±1.03^{a}
4th week	38.86±1.03	40.08±1.03	42.04±1.03
6th week	41.06±1.03^{b}	44.31±1.03^{ab}	46.82±1.03^{a}
8th week	43.16±1.03^{b}	45.05±1.03^{b}	47.90±1.03^{a}
Overall mean	40.57±1.03^{c}	42.24±1.03^{b}	44.28±1.03^{a}

$^{a, b, c}$ Means in the same rows with different superscripts differ at ($P<0.05$).

Experiment. II:

Animal performance: Feed frequency affected significantly the intakes of concentrate mixture, dry matter and water. Daily intakes of concentrate ,dry matter and water were significantly increased with increasing feed frequency from once to two or three times per day (Table 6). Increasing feed frequency from once to twice or three times feeding per day increased concentrate mixture intake by 9.1% and 15.73% , dry matter by 5.83% and 11.66%, water consumption by 42.5% and 35.6%,

respectively. Similarly Ikhatua and Adu (1983) found that feed intake increased with increasing frequencies when the amount of feed offered was restricted.

Table 5: Effect of feed frequency under *ad libitum* feeding on glucose concentration (mg/100ml) of lambs (mean ± SE).

Week of feed frequency	Feeding frequency (time/day)		
	Once	Twice	Thrice
At the beginning	77.14±3.15	79.17±3.15	78.62±3.15
2nd week	77.53±3.15	81.52±3.15	85.14±3.15
4th week	75.54±3.15^{b}	82.61±3.15^{ab}	89.31±3.15^{a}
6th week	74.34±3.15^{b}	77.72±3.15^{ab}	86.33±3.15^{a}
8th week	74.53±3.15^{b}	86.14±3.15^{a}	86.89±3.15^{a}
Overall mean	75.83±3.15^{b}	81.43±3.15^{a}	85.26±3.15^{a}

a, b, c, Means in the same rows with different superscripts differ at (P<0.05).

Table 6: Effect of feed frequency of restricted feeding treatment on feed intake, water consumption, live weight and gain of lambs.

Trait	Frequency of feeding/ day		
	Once	Twice	Thrice
Roughage (kg)	1.11±0.07	0.96±0.04	0.98±0.60
Concentrate mixture (kg)	6.04±0.09^{c}	6.59±0.07^{b}	6.99±0.08^{a}
Dry matter (kg)	6.52±0.11^{c}	6.90±0.10^{b}	7.28±0.11^{a}
Water consumption (kg)	10.72±0.46	15.27±0.92	14.54±0.60
Final body weight (kg)	57.64±2.6	59.72±3.12	64.20±2.40
Total gain (kg)	5.88±07^{b}	7.84±1.31^{b}	12.46±1.62^{a}
Average daily gain (g)	93.33±10^{c}	124.44±17^{b}	197.78±11^{a}
Feed : gain, kg / kg	17.46±3.34^{a}	11.823±1.28^{b}	7.54±0.22^{b}

a, b, c, Means in the same rows with different superscripts differ (P<0.05).

Table (6) shows that no significant differences in total gain between lambs fed once or twice per day but the three times of feeding was significantly ($P<0.05$) differed from one and two times of feeding frequencies. Average daily gain was significantly ($P<0.05$) increased from once to twice by 33.33% and from once to three times per day by 108% . The increased daily gain with increasing feed frequency may be due the to high N retention by more frequent feeding (Ulyatt *et al.*, 1984; Moir and Sommers, 1957; Mohrman *et al.*, 1959 and Gordon and Tribe, 1952). Increasing N retention should result in improving microbial protein synthesis and protein supply to the small intestine as reported by Ikhatua and Adu (1983). These results are in agreement with those reported by Thomas and Mochie (1956) who reported higher live weight gains in animals fed twice and four times daily. In Zebu cattle, Ikhatua *et al.* (1987) showed that average daily gain was significantly improved as the feeding frequency was increased from one to two and from two to three times per day.

Feed/gain ratio was significantly improved with increased feed frequency. Increasing feed frequency from once to two or three times per day, reduced significantly ($P<0.05$) feed / gain ratio by 47% and 131% of dry matter, respectively. However, no statistical significant differences were found in feed conversion ratios when lambs were fed two or three times per day (Table, 6). Similar results were found by Ikhatua and Adu (1983) in sheep and Ikhatua *et al.* (1987) in growing Zebu cattle.

Glucose concentration:

There were significant ($P<0.05$) differences in blood. glucose concentrations between lambs fed once and those fed twice and thrice at 2^{nd}, 4^{th}, 6^{th} and 8^{th} week of treatment period. Lambs fed twice had higher ($P<0.05$) glucose concentration than those lambs fed once per day when the amount of feed offered as restricted (Table 7). Moreover, there were no significant differences between lambs fed twice and three times per day throughout the feed frequency period in blood glucose concentrations. Higher blood glucose concentration for lambs fed three times per day may be attributed to higher concentrates mixture intake resulted in higher propionate production and propionate is the major source of glucose (Riss, 1983, Bauman *et al.*, 1971, Hoover *et al.*, 1984 and Kaufmann 1976).

Table 7: Effect of feed frequency under restricted feeding on glucose concentration (mg/dl) of lambs (mean ±SE)

Week of feed frequency	Frequency of feeding/ day		
	Once	Twice	Thrice
At the beginning	74.60±1.21	76.72±2.95	77.25±0.53
2nd week	69.84±2.294[b]	78.31±1.47[a]	77.78±1.65[a]
4th week	67.46±3.92[b]	75.13±1.47[a]	78.84±2.17[a]
6th week	70..64±3.46[b]	78.31±1.47[a]	79±37±1.65[a]
8th week	74.87±2.35[b]	81.48±1.91[a]	82.28±3.44[a]
Overall mean	71.48±1.31[b]	77.99±0.92[a]	79.10±0.92[a]

[a, b, c] Means in the same rows with different superscripts differ at (P<0.05)

Table 8: Effect of feed frequency at restricted feeding on blood urea nitrogen concentration (mg/dl) of lambs (mean ±SE)

Week of feed frequency	Frequency of feeding/ day		
	Once	Twice	Thrice
At the beginning	41.67±0.30	41.61±0.42	41.67±0.26[a]
2nd week	40.97±0.89[b]	43.05±0.53[ab]	42.24±0.93[a]
4th week	41.61±0.15[b]	42.99±0.29[ab]	44.50±0.55[a]
6th week	42.48±0.78[b]	44.79±0.82[a]	45.83±0.50[a]
8th week	42.71±0.63[b]	45.08±0.64[a]	44.68±1.57[a]
Overall mean	41.89±0.29[b]	43.51±0.40[a]	43.78±0.54[a]

[a, b, c] Means in the same rows with different superscripts differ at (P<0.05).

Urea nitrogen concentration:

There was a significant (P<0.05) difference in blood urea nitrogen concentration throughout feed frequency period between lambs fed once and those fed twice or three times per day, where lambs fed one time per day had lower urea concentration than those fed two or three times per day when the amount of offered feed was restricted Table 8). Overall mean of urea concentration was higher for lambs fed twice and three times per day than those fed once per day (43.5, 43.8 vs. 41.9 mg/dl, respectively,). Similar results were found by Thomas and Morag (1976) since they reported that urea concentration was lower in Ayrshire cows fed continually than those fed twice per day. Higher serum urea concentration with increased feed frequency may be related to high protein intake (Table, 6). Madsen (1983) stated that when amino acids are utilized in the liver gliconeogenesis, the amino groups are converted

to urea. The highest level of urea production is of the fast growing animals with higher protein intake. Similarly, Clinet *et al.*, (1998) reported that the concentration of urea nitrogen was greater in mature ewes fed soybean meal once every 24 hr than those fed once every 72 hr.

Conclusion:

In both feed frequency trials (*ad libitum* and restricted), feed intake, water consumption and daily gain were increased with increasing feed frequency. But lambs fed more frequent feeding under *ad libitum* level consumed more water and feed intake than those fed frequent feeding under restricted regime. Lambs fed more frequent feeding was efficient in converting feed to gain under restricted or *ad libitum* levels, but lambs fed more frequent feeding under restricted level were more efficient in converting feed to gain than those fed more frequent feeding under *ad libitum* level. Lambs fed more frequent feeding had higher overall mean of blood glucose and urea concentrations under *ad libitum* or restricted levels, but lambs fed frequent feeding under *ad libitum* level had higher mean glucose and urea concentration than those under restricted feeding

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