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Effect of Concentrate Feeding Frequency on Animal Performance and Feed Utilization of Pregnant Abu-Duliek Ewes Under Halaib Region Conditions

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Abstract

Concentrate supplementation is a critical factor in late pregnancy ewes' feeding but feeding concentrate once daily can result in many negative effects on animal performance such as rumen acidosis. This study was aimed to investigate the effect of concentrate feeding frequency on feed intake, nutrients digestibility and lambs' birth weight of pregnant Abu-Duleik ewes under arid conditions of Halaib region. Thirty healthy of Abu-Duleik ewes (31.0± 4.86 Kg) at late pregnancy period were randomly divided into three groups that fed on alfalfa hay and concentrate feed mixture (CFM). All groups were fed on alfalfa hay in the morning, while the first group (G1) was fed on CFM in equally two-parts (both in the morning and the afternoon). The second group (G2) was fed on CFM in one part (only in the morning). The third group (G3) was fed on CFM in one part (only in the afternoon). Feed intake was higher in G1 than G2 and G3 but without significant difference. Nutrients digestibility of G1 was the highest among the groups but with insignificant difference, except for Acid detergent fiber digestibility (ADFD%) which was significantly differed ($P<0.05$). Methane production was lower in G1 than G2 and G3 without a significant difference among groups. Blood serum metabolites were in normal range in all groups. Birth wight of lambs was significantly higher in G1 than the other groups. Concentrate feeding frequency practice can be used to enhance feed utilization and lambs' birth weight of pregnant Abu-Duleik ewes.

Keywords: Feeding frequency, feed utilization, methane production, birth weight, Abu-duliek sheep and Halaib region

Introduction

Concentrate supplementary feeding is a necessary practice to enhance sheep productivity especially at critical physiological stages (such as pregnancy, lactation and growth) that require higher levels of energy and protein than maintenance requirement **(Shetaewi and Ross 1987; Askar *et al*., 2014 and Belkasmi *et al*., 2023)**. However, feeding concentrate with readily fermented carbohydrate at once daily can stimulate sever increase in volatile fatty acids (VFA's) and lactic acid concentrations in rumen which lead to ruminal acidosis that declines rumen fermentation and subsequently suppress animal performance **(Cabrita *et al*., 2006).** Moreover, rumen acidosis is an inducing factor for releasing bacterial endotoxin (lipo-polysaccharide) in the rumen, that may be translocated into the blood stream and induced inflammatory status **(Krogstad and Bradford, 2023).** To overcome rapidly lowering rumen pH and rumen acidosis there are many nutritional tools like using ionophores, sodium bicarbonate and feeding frequency. Ionophores (such as monensin, lasalocid and salinomycin) are a group of antibiotics that are used as feed additives in ruminant fed on high concentrate diet to prevent reduction in rumen pH and improve feed efficiency and prevent coccidiosis. Ionophores can prevent acidosis by reducing lactic acid producing bacteria hence lowering lactic acid accumulation and increase propionic acid that consumes metabolic hydrogen in the rumen that indirectly reduces methane production. On the other hand, incorrect dosage of the ionophores can cause toxicity and even death. Also, using ionophores for long period may be raised antibiotic resistance hazard that supports ionophores banning in European Union and some other countries **(Al Jassim *et al.,* 2016; Marques and Cooke 2021 and Ekinci *et al*., 2023).**

Sodium bicarbonate ($NaHCO_3$) is a common practice and affordable buffer that is already used worldwide against acidosis in ruminant fed on high cereal diet (for both beef and dairy production). However, high percentage of sodium bicarbonate can reduce feed intake, increasing water intake and decreasing VFA absorption **(Tripathi *et al*., 2004 and González *et al*., 2008).**

Feeding frequency is a feeding practice that divides concentrated feeds or whole diet into equal parts and offered to animals in more than one time during the day. Feeding frequency can decrease fluctuation of ruminal ammonia, volatile fatty acids and rumen pH. Moreover, feeding frequency maybe be enhanced synchronization between crude protein degradation and volatile fatty acids and microbial protein production in ruminal fluid. Additionally, feeding frequency can decrease a competition between animals in group feeding **(Cabrita *et al*., 2006; Macmillan *et al.,* 2017 and Nayel *et al.,* 2022).** Sufficient feeding of ewes during late pregnancy is a critical factor that affects lambs' birth weight and mammary glands development. Ewes fed on 100 and 60% of their metabolizable energy (ME) requirements in late pregnancy period that resulted in higher pregnant ewes wight until lambing, higher lambs' birth weight and higher colostrum yield for 100% than 60% group (**Lashein *et al*., 2019**). Improving lambs birth weight can increase survivability, growth rate and meat quality and decrease preweaning morbidity and mortality rate (**Mukasa-Mugerwa 1994; Andrés *et al*., 2020 and Bancheva *et al*., 2022**). Abu-Duleik (Abou-Delik or Abu-Dleek) sheep are found in Halaib and some regions of the Red Sea governorate, Egypt. Abu-Duleik sheep have many characteristics that support this breed to live in arid regions, such as their body coat is hair, have long legs and their necks with thin dewlaps (**Mohammady *et al*., 2019 and Aboul Naga and Abdelsabour 2023).**

There is no information about the response of pregnant Abu-Duleik sheep to feeding frequency practice. So, the objective of the present study was to investigate the impact of concentrate feeding frequency during late pregnancy of Abu-Duleik ewes on performance, nutrients digestibility, energy utilization, and birth weight of lambs under arid conditions of Halaib region.

Material and methods

Area of study

The present study was carried out at Ras Hedraba Valley region, Shalatin experimental research station, Halaib, Desert Research Center, Egypt. The station located in the Shalatin - Abu Ramad- Halaib triangle region, Red Sea Governorate, 1200 km southeastern from Cairo (the capital of Egypt) with latitude 22.00.720 N and longitude 36.48.955 E; 96 degrees above sea level. In cooperation with Animal Production Department, Faculty of Agriculture, New valley University.

Ethical approval

Animal management and handling were done under the ethical regulation of the animal and poultry division, Desert Research Center (DRC) and Animal Production Department, Faculty of Agriculture, New valley University.

Experimental design

Animals and feeding

Thirty healthy of adult Abu-Duleik ewes (31.0± 4.86 Kg) at late pregnancy stage were randomly divided into three groups (10 ewes per each) and fed (in groups) for two months on alfalfa hay as 1.6% and concentrate feed mixture (CFM) as 2% of their live body weight (LBW) according to **NRC (2007)** as follows:

G1: Alfalfa hay (in the morning) + CFM (in two parts (2X) in the morning and afternoon)

G2: Alfalfa hay (in the morning) + CFM (in one part (1X) in the morning)

G3: Alfalfa hay (in the morning) + CFM (in one part (1X) in the afternoon)

Animals were housed indoors in well-ventilated pens and were weighed biweekly to adjust offered feed amounts. Ewes and their lambs were weighed on lambing day. Fresh water was available two times daily. The chemical composition of feed ingredients is shown in table (1).

Nutrients digestibility

Digestion experiment was conducted using fecal bags method. Animals were fed individually (five animals per group) on alfalfa hay and CFM for five days of adaptation period and for seven days of collection period. Feeds, refusal feeds (if any) and feces were weighted daily. Also, water intake was recorded daily. Fecal bags were emptied twice daily, first time at the early morning (07:00 AM) and the sconed time at 6:00 PM and 10% subsamples were taken and oven dried at 60ºC for the constant weight then kept for further analysis. The digestibility was determined using the acid insoluble ash (AIA) method as internal marker according to **Schneider and Flatt (1975)** and **Van keulen and Young (1977).**

Ruminal fermentation parameters

At the end of the experiment, rumen liquor was withdrawn by using stomach tube before morning feeding (zero time), 3 and 8hr after feeding. The pH value was measured immediately using a portable pH meter. The rumen liquor samples were filtered through three layers of cheese cloth. Then rumen liquor samples were preserved by using drops of toluene and paraffin oil and kept at –20 °C for determination of total volatile fatty acids (TVFA' s), which was determined by steam distillation and ammonia–nitrogen (NH_3-N) was determined using micro-Kjeldahl's method according to **Annison (1954)** and **AOAC (1990),** respectively.

Blood sampling and analysis

Blood samples were collected before feeding at the end of the experiment from jugular vein into clean and dry tubes. Serum samples were separated by centrifugation at 4000 rpm for 15 min and stored at -20ºc until further analyses. Serum total portion (TP), albumin (AL), (globulin (GL) was calculated by difference), blood urea nitrogen (BUN), creatinine, aspartate amino transferase (AST) and alanine amino transferase (ALT) were colorimetry analyzed by using commercial kits (Bio diagnostic company, Egypt).

Chemical Analysis

Proximate analysis of feeds and feces samples were determined for dry matter (DM), Ash, organic matter (OM), ether extract (EE) and crude protein (CP) according to **AOAC (1990)**. Fiber fractions as neutral detergent fiber (NDF) and acid detergent fiber (ADF) were conducted according to **Van Soest and Robertson (1985)** using ANKOM Model 220 Fiber Analyzer (Macedon, NY, USA). Acid insoluble ash (AIA), as an internal marker, was carried out according to the method of **Van Keulen and Young (1977)**. Gross energy of feeds and feces were determined using bomb calorimeter (C200, IKA Works Inc., Staufen, Germany). Total carbohydrate (CHO), non-fiber carbohydrates (NFC), methane production, total digestible nutrients (TDN) and metabolizable energy (ME) were calculated by different prediction equations as follows:

Table (1): Chemical composition of concentrate feed mixture and alfalfa hay (% on DM Basis)

Ingredients	CFM	Alfalfa hay
Dry matter%	88.50	93.77
Gross Energy, Mcal/Kg DM	3.92	3.79
Chemical composition %		
Organic matter	87.99	86.55
Ash	12.01	13.45
Crude protein	14.32	14.50
Ether extract	3.26	1.00
Neutral detergent fiber	34.60	55.90
Acid detergent fiber	13.00	28.27
Non-fiber Carbohydrates *	35.81	15.15
Total carbohydrate*	70.41	71.05

*Concentrate feed mixture (CFM) consisted of yellow corn (55%), Soybean meal (20%), Wheat bran (20%), sodium bicarbonate (0.1%), limestone (2.5%), Common salt (1.5%), Anti-toxins (0.1%), Yeast (0.3%), Vitamins and microelements premix (0.5%). (each 3 kg premix contains vitamin A: 10,000,000 IU, vitamin D3: 200,000 IU, vitamin E: 15,000 mg, manganese: 70 g, zinc: 60 g, iron: 50 g, copper: 15 g, iodine: 3 g, selenium: 0.3 g and cobalt: 0.75 g). *Calculated value.

Calculation

Total carbohydrate (CHO):

CHO% = 100 – (CP% + EE% + Ash%) according to **Fox *et al*., (2004)**

Non-fiber Carbohydrates (NFC):

NFC% = 100% - (CP% + NDF% + EE% + Ash%) according to **Hall (2003).**

Methane prediction equation:

CH_4 (g/d) = 4.72+ 11.8*DMI– 0.0440*OMD + 0.116*BW

Where DMI: dry matter intake (Kg), OMD: organic matter digestibility percentage and BW was animal live body weight (Kg) according to **Belanche *et al*., (2023)**.

Total digestible nutrients (TDN) and metabolizable energy (ME)

TDN% = DE/ 0.04409 according to **NRC (2007).**

DE: digestible energy (Mcal/KgDM)

Metabolizable energy = 0.82 x DE, according to **NRC (2007).**

Statistical analysis

Differences among groups were checked using general linear model (GLM) procedure (one way analysis of variance), Duncan's new multiple range test (**Duncan, 1955**) was used to compare among means. The GLM procedure of **SAS (1996)** was employed. The following statistical model was adopted:

Yij = μ + Gi + eij

Where: Yij = observation, μ = over all mean, Gi = the effect of the groups (G = 1, 2, 3; 1 = two times concentrate frequency of feeding; 2 = one time morning concentrate frequency of feeding; 3 = one time afternoon concentrate frequency of feeding) and eij = experimental error, assumed to be randomly distributed (0, σ^2).

Results and discussion

Feed intake and digestibility

Concentrate, hay and total dry matter intake (DMI) values were insignificant among the three groups (Table 2). Where G1 (Animals fed on the half amount of concentrate in the morning and half in afternoon) tended to have a slightly positive higher values among the groups. This may be due to the high values of nutrients digestibility in G1 (table 3). Generally, many researchers reported that increasing feeding frequency resulted in increasing DMI compared to control (**Taie 1996; Carter *et al.,* 1990 and Macmillan *et al.,* 2017).**

Water intake values were insignificant among the groups. Water intake wase higher in G3 than G1 and G2. That confirmed by **Abou El-Nasr *et al*., (1994)** reported that offering concentrate supplementation (CFM or barley grain) in afternoon time resulted in higher water intake than in morning time.

Nutrient digestibility, nutritive value, energy utilization and methane production are shown in table (3). Digestibility of different nutrients were insignificant among the groups (except for ADFD%) with a positive tendency to increase digestibility values for G1. Acid detergent fiber digestibility (ADFD%) was significant (P<0.05) and the G1 were higher over G2 and G3 by 31.85 and 40.12%, respectively. That can be explained by reducing rumen pH fluctuation in G1(Table 6) that increases cellulolytic microbial activity **(Bunting *et al*., 1987).** Low ruminal pH appeared to prevent a tight attachment of bacteria to plant cell wall and therefore decreasing ruminal fiber degradation **(Cheng *et al*., 1984). Bunting *et al*., (1987)** reported that ADFD% in rumen (as percent from total tract digestibility) was 63.5 and 54.8% for 2X (feeding frequency equaled two times) and 4X of cows fed on good quality roughage, respectively. Moreover, **Taie (1996)** reported that sheep apparent digestibility of DM, CP, CF% and rumen retention time were the highest for 2X followed by 3X and the least for 1X. Increasing rumen retention time provides favorable conditions for fiber microbial degradation that is characterized by longer lag time (**Hobson and Stewart, 1997). Nayel *et al*., (2022)** reported that concentrate feeding frequency as 1X, 2X and 3X in Barki ewes resulted in no differences on DMD% and CPD% But CFD% tended to increase with increasing feeding frequency.

Values of total digestible nutrients (TDN%) recorded insignificant differences among groups. The TDN value of G1 was the highest among the groups and represented 8.6 and 10.1% over G2 and G3, respectively. That was confirmed by **Taie (1996)** who reported that increasing feeding frequency will increase nutritive value in Ossimi rams fed on 1X, 2X and 3X diets that resulted in 64.74, 68.28 and 67.17% for TDN%, 8.95, 9.74 and 9.56% for DCP%, respectively.

Metabolizable energy (ME) values were insignificant among the groups but G1 achieved the highest value of ME over G2 and G2 by 8.54

and 9.64%, respectively. Metabolizable energy reflected the TDN and DE values.

Methane production from ruminant is considered nutritional and environmental issues. Ruminants lose on average 7% of gross energy as enteric methane gas production. Additionally, Methane is considered one of greenhouse gases that are responsible for global warming phenomena and its worldwide negative effects (**Johnson and Johnson, 1995 and Belanche *et al*., 2023**).

Table (2): Effect of concentrate feeding frequency on feed and water intake during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
Body weight, Kg	30.80	32.20	30.00	1.25
Body weight ($W^{0.75}$)	13.048	13.506	12.772	0.40
Feed Intake				
Concentrate intake				
g/d	528.88	511.82	503.80	22.58
g/kg BW	17.11	15.91	16.91	0.35
g/ $BW^{0.75}$	33.58	33.06	32.34	1.18
Intake/BW%	1.71	1.59	1.69	0.04
Hay intake				
g/d	435.62	442.68	406.70	11.99
g/kg BW	14.32	13.94	13.98	0.61
g/ $BW^{0.75}$	40.26	37.86	39.35	0.86
Intake/BW%	1.43	1.39	1.40	0.06
Total DM intake				
g/d	964.49	954.50	910.50	30.01
g/kg BW	31.43	29.85	30.89	0.82
g/ $BW^{0.75}$	73.84	70.92	71.69	1.54
Intake/BW%	3.14	2.99	3.09	0.08
Nutrient intake (g/d)				
OM	842.39	835.70	795.29	30.94
CP	140.85	136.89	131.12	4.41
NDF	425.37	451.87	401.66	14.37
ADF	193.85	191.68	180.47	5.50
Water intake				
Water intake, ml	2126.48	2112.50	2202.50	197.35
Water ml/DM intake g	2.20	2.21	2.42	0.14
Water intake/BW %	6.90	6.56	7.34	0.49

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean).

Predicted methane production (g/d) values were insignificant, but group (G1) was lower in methane production by 7.71 and 2.36% than G2 and G3, respectively. **Knox and Ward (1961)** reported that increasing feeding frequency decreased acetic acid and increased propionic acid and subsequently decreased acetic/propionic ratio that will decreases methane production, maybe due to competition between propionic acid producing bacteria and methanogenic bacteria on rumen metabolic hydrogen **(Williams *et al.,* 2019).** On other hand **Judy *et al*., (2018)** and **Benchaar and Hassanat (2020)** found that frequency of feeding had slightly and non-significant increase in methane production.

Table (3): Effect of concentrate feeding frequency on nutrient digestibility, energy utilization and methane production during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
Digestibility (%)				
DM	61.03	60.26	57.27	1.38
OM	66.18	63.84	65.20	1.27
CP	75.33	79.54	75.06	1.40
NDF	50.84	50.34	46.14	2.14
ADF	37.83[a]	25.78[b]	22.65[b]	2.71
nutritive value (%)				
TDN	59.86	55.12	54.39	1.55
DCP	10.85	11.46	10.81	0.20
Energy utilization (Mcal/KgDM)				
GE intake	3.86	3.86	3.86	0.001
DE	2.64	2.43	2.40	0.068
ME	2.16	1.99	1.97	0.056
ME/GE	0.56	0.52	0.51	0.014
Methane* (g/d)	15.70	16.91	16.07	0.558
Methane Energy	0.207	0.223	0.212	0.008
Methane/GE, %	5.37	5.79	5.50	0.190
Methane/DE, %	7.87	9.20	8.87	0.295
Methane/ME, %	9.60	11.22	10.82	0.359

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). [a, b]: Means followed by different superscripts within each row are significantly different ($P \leq 0.05$).
*Methane CH_4 (g/d) = 4.72+ 11.8*DMI– 0.0440*OMD + 0.116*BW (Belanche *et al*., ,2023).

Ammonia nitrogen (NH_3-N) concentration

Ammonia nitrogen concentration is affected by the summation of ruminal microbial degradation rate of crude protein from feed and urea from saliva. Also, absorption rate of ammonia from rumen wall. Ammonia is a vital nitrogen source for rumen microorganisms, especially cellulolytic bacteria **(Hobson and Stewart, 1997).** Ammonia nitrogen (NH_3-N) values are shown in table (4). Concentrate feeding frequency in afternoon influenced NH_3-N concentrations ($P < 0.05$) in G3 (33.25 mg/dl) and G1(30.80 mg/dl) even with half amount of concentrate. After three hours of feeding NH_3-N concentrations were reached their peak value (33.25 mg/dl) in G1 and G2 ($P < 0.05$) that might be due to low NDF content (Table 1) for CFM (34.6%) compared to alfalfa hay (55.90%). Moreover, NDF content is negatively correlated with ruminal CP degradability hence ruminal ammonia concentration (**Hristov and Ropp, 2003).** Then NH_3-N concentrations decreased gradually with time (8h). On the other hand, **Afify *et al*., (2004)** reported that feeding concentrate for once, twice or three times daily led to non-significant differences in ammonia-N concentration among groups.

Table (4): Effect of concentrate feeding frequency on ruminal ammonia-nitrogen concentrations (mg/dl) during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
0h	30.80^{b}	24.15^{c}	33.25^{a}	1.21
3h	33.25^{a}	33.25^{a}	26.25^{b}	1.09
8h	26.25^{a}	24.85^{a}	18.90^{b}	1.03

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). ^{a,b,c} Means followed by different superscripts within the same row are significantly different (P≤0.05).

TVFA's concentration

The Volatile fatty acids (TVFA's) are the end products of ruminal anaerobic microbial fermentation that provide the ruminant animals with a major source of energy. The TVFA's concentration is regulated by a balance between production and absorption. **(Van Soest, 1994).**

Volatile fatty acids (VFA's) concentrations in the ruminal fluid are shown in table (5). Volatile fatty acids concentrations before feeding were higher in G3 and G1 than G2 (P < 0.05). However, Volatile fatty acids concentration reached its peak value (11.51meq/dl) after feeding concentrate at one time in the morning (at 3h) for G2 (P < 0.05). That can be explained by higher Non-fiber carbohydrates (NFC) content (Table1) in CFM (35.81%) than hay alfalfa hay (15.15%). Additionally, **Hassan *et al*., (2008)** reported that CFM had higher dry matter solubility in water (46.76%) versus lower dry matter solubility of berseem hay (30.95%). Concentrations of TVFA's at 8h decreased proportionally from TVFA's concentrations at 3h. Feeding frequency (G1) achieved the lowest fluctuation of volatile fatty acids concentration among the groups which confirmed by results of **Taie (1996)** who reported less rumen VFA's fluctuation in sheep fed 2X compared to control.

Table (5): Effect of concentrate feeding frequency on ruminal TVFA´s concentrations (meq/dl) during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
0h	6.36^{b}	4.55^{c}	7.31^{a}	0.361
3h	8.93^{b}	11.51^{a}	5.89^{c}	0.697
8h	8.33^{b}	9.09^{a}	5.16^{c}	0.522

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). ^{a,b,c} Means followed by different superscripts within the same row are significantly different (P≤0.05).

Rumen pH values

Rumen pH is considered as an important parameter that is affected by many factors like roughage to concentrate ratio (R:C), concentrate feeding level, feeding frequency, rumination time and sampling time after feeding. On the other hand, rumen pH controls microbial feed degradation and nutrient absorption rates. **(Van Soest, 1994; Lana *et al*., 1998** and **Krause and Oetzel, 2006).**

Rumen pH values were significantly differed (P < 0.05) among treatments (Table 6). The lowest pH value was achieved in G2 (P < 0.05) at 3h due to feeding concentrate at one time in the morning and that was confirmed by sever increase in TVFA's concentration in the same group (Table 5). On the other hand, feeding frequency (G1) achieved the lowest fluctuation of rumen pH among the groups. That was confirmed by **Carter *et al.,* (1990)** who reported that increasing feeding frequency resulted in increasing saliva secretion that contains buffer (sodium bicarbonate) that prevents sever fall in rumen pH. Additionally, increasing feeding frequency increased rumination time **(Macmillan *et al*., 2017).** In the same way, **Taie (1996)** reported that Ossimi rams fed on frequency of feeding for 1X, 2X and 3X diets that resulted in ruminal pH, VFA's and NH3-N values were fluctuated less for 2X and 3X than 1X, respectively. These results agreed with **Sun *et al*., (2019)** who reported that increasing feeding frequency reduced the variation in rumen fermentation parameters over time.

Table (6): Effect of concentrate feeding frequency on ruminal pH during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
0h	6.25^{b}	6.34^{a}	6.20^{c}	0.018
3h	6.12^{b}	6.00^{c}	6.27^{a}	0.034
8h	6.15^{b}	6.11^{c}	6.31^{a}	0.026

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). ^{a,b,c} Means followed by different superscripts within the same row are significantly different (P≤0.05).

Blood serum metabolites

Serum blood biochemical parameters are shown in Serum blood biochemical parameters were insignificant (P>0.05) among the groups (Table 7) and located in the normal range values of sheep according to **Jackson and Cockcroft (2002).** Although AST activity was in normal range, G1 recorded the lowest value by 33.64 and 43.46% than G2 and G3, respectively. That indicated sheep in G1 might be under lower inflammatory stress than the other groups. Additionally, **Nasrollahi *et al*., (2019)** reported that cows with lower rumen pH had higher AST activity than cows with higher rumen pH.

Body weight changes of pregnant ewes and birth weight of lambs

The values of body weight changes of Abu-Duleik ewes during late pregnancy period and lambs' birth weight are shown in table (8). There were insignificant differences among the experimental groups during the 60 and 30 days before lambing (parturition) and at the lambing day too. Birth wight of lambs in group one (G1) was the highest (2.58 Kg) among the groups with significant difference (P < 0.05). Additionally, that may be explained by the highest DMI, OMI, TDN and ME values in pregnant ewes in G1 (Table 2 and 3). Concentrate supplementary feeding at late pregnancy is more important in improving lambs birth weight and lambs' survival rate than mid pregnancy **(Mukasa-Mugerwa *et al*., 1994).** Additionally, **Nayel *et al.,* (2022)** reported that there was a tendency to increase Barki lambs birth weight with increasing concentrate feeding frequency of their ewes. The lambs birth weight values in present study as percent from ewes' body weight at lambing day were 9.63, 8.37 and 9.04% for G1 and G2 and G3, respectively. The present results are closely related to **Mohammady *et al*., (2019)** who found that Abu-Duleik lambs' birth weight on average was about 10.8% of ewes weight at lambing day. Improving lambs birth weight can increase viability, survivability and decrease preweaning mortality **(Mukasa-Mugerwa 1994 and Bancheva *et al.,* 2022**).

Table (7): Effect of concentrate feeding frequency on biochemical serum blood parameter during late pregnancy period of Abu-Duleik ewes

Item	G1	G2	G3	SEM
Total protein, g/dl	6.75	7.20	7.16	0.12
Albumin, g/dl	3.88	4.28	4.42	0.11
Globulin, g/dl	2.87	2.92	2.74	0.04
AST, IU/mL	90.09	120.4	129.25	12.85
ALT, IU/mL	35.45	33.26	35.91	1.53
BUN, mg/dl	21.22	18.56	23.48	1.43
Creatinine, mg/dl	1.04	0.99	0.96	0.07

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). BUN (Blood urea nitrogen). AST (aspartate amino transferase). ALT (alanine amino transferase).

Table (8): Effect of concentrate feeding frequency on body weight changes of Abu-Duleik ewes during pregnancy period and their lambs' birth weight

Item	G1	G2	G3	SEM
Pregnant ewes' body weight (Kg)				
60 days before lambing	29.21	31.57	30.03	1.44
30 days before lambing	30.75	33.00	31.50	1.43
Lambing day	26.80	29.63	27.88	1.46
Birth weight of lambs (Kg)	2.58^{a}	2.48^{c}	2.52^{b}	0.01

G1: Animals fed on concentrate in the morning and afternoon, G2: Animals fed on concentrate in in the morning, G3: Animals fed on concentrate in the afternoon. SEM (Standard error of mean). ^{a,b,c} Means followed by different superscripts within the same row are significantly different (P≤0.05).

Conclusion

It can be concluded that using concentrate feeding frequency (two times per day) practice improved feed intake, nutrients digestibility and nutritive value and in the same way it increased lambs' birth weight and decreased methane production under conditions of Halaib region. These results can be recommended in sheep management program for sustainable and affordable improvement of pregnant Abu-Duleik ewes and their lambs.

References

Abou El-Nasr, H. M., Farid, M. F. A., & Khamis, H. S. (1994). Feed intake and utilization in sheep fed roughage diets: effects of type and time of concentrate supplementation. *Journal of Arid Environments*, *27*(3), 297-308.

Aboul Naga, A. M., & Abdelsabour, T. (2023). Review of Sheep and Goat Research and Development in Egypt Since the Forties: II-Phenotypic Characteristics, Production, and Reproduction Performance of Local Sheep Breeds. *Journal of Animal and Poultry Production*, *14*(6), 43-52.

Afify, A. A., Hassan, H. Z., & Mohy El-Deen, M. M. (2004). Effect of frequency of feeding on productive and reproductive performance of Egyptian buffalo heifers. *J. Agric. Sci. Mansoura Univ.*, *29*(3), 1183-1195.

Al Jassim, R. A. M., Shahsavari, A., Owen, H., & Khamas, W. (2016). Gross pathology, biochemistry and histopathology of selected organs of camels suffering from suspected monensin toxicosis in Australia. *J. Veterinary Sci. Technology*, *7*(3), 315.

Andrés, S., Valdés, C., Santos, A., Mateo, J., & Giráldez, F. J. (2020). Effects of birth weight on animal performance, fattening traits and meat quality of lambs. *Animals*, *10*(12), 2364.

Annison, E. F. (1954). Some observations on volatile fatty acids in sheep's rumen. *Biochem. J.*, *57*, 400-405.

AOAC. (1990). *Official Methods of Analysis* (15th ed.). Association of Official Analytical Chemists.

Askar, A. R., Salama, R., El-Shaer, H. M., Safwat, M. A., Poraei, M., Nassar, M. S., Badawy, H. S., & Raef, O. (2014). Evaluation of the use of arid-area rangelands by grazing sheep: Effect of season and supplementary feeding. *Small Ruminant Research*, *121*(2-3), 262-270.

Bancheva, T., Stoycheva, S., Dimitrova, T., Markov, N., Mondeshka, L., & Hristov, M. (2022). Impact of various factors on live birth weight lambs-review. *Scientific Papers: Series D, Animal Science-The International Session of Scientific Communications of the Faculty of Animal Science*, *65*(1), 259-266.

Belanche, A., Hristov, A. N., van Lingen, H. J., Denman, S. E., Kebreab, E., Schwarm, A., Kreuzer, M., Niu, M., Eug, M., Niderkorn, V., Martin, C., Archimede, H., McGee, M., Reynolds, C. K., Crompton, L. A., Bayat, A. R., Yu, Z., Bannink, A., Dijkstra, J., Chaves, A. V., Clark, H., Muetzel, S., Lind, V., Moorby, J., Rooke, J. A., Aubry, A., Antezana, W., Wang, M., Hegarty, R., Oddy, V. H., Hill, J., Vercoe, P. E., Savian, J. V., Abdalla, A. L., Soltan, Y. A., Monteiro, A. L. G., Ku-Vera, J. C., Jaurena, G., Gomez-Bravo, C. A., Mayorga, O. L., Congio, G. F. S., & Yanez-Ruiz, D. R. (2023). Prediction of enteric methane emissions by sheep using an intercontinental database. *J. Clean Prod.*, *384*, 135523.

Belkasmi, F., Patra, A. K., Lourencon, R. V., Puchala, R., Dawson, L. J., Ribeiro, L. P., Encinas, F., & Goetsch, A. L. (2023). Effects of the level and composition of concentrate supplements before breeding and in early gestation on production of different hair sheep breeds. *Animals*, *13*(5), 814.

Benchaar, C., & Hassanat, F. (2020). Frequency of diet delivery to dairy cows: Effect on nutrient digestion, rumen fermentation, methane production, nitrogen utilization, and milk production. *Journal of dairy science*, *103*(8), 7094-7109.

Bunting, L. D., Howard, M. D., Muntifering, R. B., Dawson, K. A., & Boling, J. A. (1987). Effect of feeding frequency on forage fiber and nitrogen utilization in sheep. *Journal of animal science*, *64*(4), 1170-1177.

Cabrita, A. R. J., Dewhurst, R. J., Abreu, J. M. F., & Fonseca, A. J. M. (2006). Evaluation of the effects of synchronising the availability of N and energy on rumen function and production responses of dairy cows–a review. *Animal Research*, *55*(1), 1-24.

Carter, R. R., Allen, O. B., & Grovum, W. L. (1990). The effect of feeding frequency and meal size on amounts of total and parotid saliva secreted by sheep. *British Journal of Nutrition*, *63*(2), 305-318.

Cheng, K. J., Stewart, C. S., Dinsdale, D., & Costerton, A. (1984). Electron microscopy of bacteria involved in the digestion of plant cell wall. *Anim. Feed. Sci. Technol.*, *10*, 93.

Duncan, D. B. (1955). Multiple Range and Multiple F Test. *Biometrics*, *11*, 1-24.

Ekinci, İ. B., Chłodowska, A., & Olejnik, M. (2023). Ionophore toxicity in animals: a review of clinical and molecular aspects. *International Journal of Molecular Sciences*, *24*(2), 1696.

Fox, D. G., Tedeschi, L. O., Tylutki, T. P., Russell, J. B., Van Amburgh, M. E., Chase, L. E., & Overton, T. R. (2004). The Cornell Net Carbohydrate and Protein System model for evaluating herd nutrition and nutrient excretion. *Animal Feed Science and Technology*, *112*(1-4), 29-78.

González, L. A., Ferret, A., Manteca, X., & Calsamiglia, S. (2008). Increasing sodium bicarbonate level in high-concentrate diets for heifers. I. Effects on intake, water consumption and ruminal fermentation. *Animal*, *2*(5), 705-712.

Hall, M. B. (2003). Challenges with nonfiber carbohydrate methods. *Journal of animal science*, *81*(12), 3226-3232.

Hassan, N., Hanafy, M. A., Abdul Aziz, G. M., & Ghandour, M. M. A. (2008). Solubility of some minerals in feedstuffs incubated in rumen of Barki sheep fed different types of diet. *Journal of Animal and Poultry Production*, *33*(3), 1851-1862.

Hristov, A. N., & Ropp, J. K. (2003). Effect of dietary carbohydrate composition and availability on utilization of ruminal ammonia nitrogen for milk protein synthesis in dairy cows. *Journal of Dairy Science*, *86*(7), 2416-2427.

Hobson, P. N., & Stewart, C. S. (1997). *Rumen microbial ecosystem* (2nd Ed.). Chapman and Hall.

Jackson, P. G. G., & Cockcroft, P. D. (2002). *Clinical examination of farm animals*. Blackwell Science Ltd.

Johnson, K. A., & Johnson, D. E. (1995). Methane emissions from cattle. *Journal of animal science*, *73*(8), 2483-2492.

Judy, J. V., Bachman, G. C., Brown-Brandl, T. M., Fernando, S. C., Hales, K. E., Miller, P. S., & Kononoff, P. J. (2018). Energy balance and diurnal variation in methane production as affected by feeding frequency in Jersey cows in late lactation. *Journal of dairy science*, *101*(12), 10899-10910.

Knox, K. L., & Ward, G. M. (1961). Rumen concentrations of volatile fatty acids as affected by feeding frequency. *Journal of Dairy Science*, *44*, 1550-1553.

Krause, K. M., & Oetzel, G. R. (2006). Understanding and preventing subacute ruminal acidosis in dairy herds: A review. *Animal feed science and technology*, *126*(3-4), 215-236.

Krogstad, K. C., & Bradford, B. J. (2023). Does feeding starch contribute to the risk of systemic inflammation in dairy cattle? *JDS communications*, *4*(1), 14-18.

Lana, R. P., Russell, J. B., & Van Amburgh, M. E. (1998). The role of pH in regulating ruminal methane and ammonia production. *Journal of animal science*, *76*(8), 2190-2196.

Lashein, M. E., Abd-Allah, M., Hussein, A. M. A., & Tawfik, M. H. (2019). Effects of nutrition plane on productive performances of Ossimi ewes and their offspring during pregnancy and lactation periods. *Archives of Agriculture Sciences Journal*, *2*(3), 1-14.

Macmillan, K., Gao, X., & Oba, M. (2017). Increased feeding frequency increased milk fat yield and may reduce the severity of subacute ruminal acidosis in higher-risk cows. *Journal of dairy science*, *100*(2), 1045-1054.

Marques, R. D. S., & Cooke, R. F. (2021). Effects of ionophores on ruminal function of beef cattle. *Animals*, *11*(10), 2871.

Mohammady, M. I., Hammam, A. H., & Farrag, B. (2019). Biotic and economic indicators of Abou-Delik sheep raised in Halaieb-Shalateen-Abouramad triangle of Egypt. *Animal Science Reporter*, *12*(1), 1-10.

Mukasa-Mugerwa, E., Said, A. N., Lahlou-Kassi, A., Sherington, J., & Mutiga, E. R. (1994). Birth weight as a risk factor for perinatal lamb mortality, and the effects of stage of pregnant ewe supplementation and gestation weight gain in Ethiopian Menz sheep. *Preventive Veterinary Medicine*, *19*(1), 45-56.

Nasrollahi, S. M., Zali, A., Ghorbani, G. R., Kahyani, A., & Beauchemin, K. A. (2019). Blood metabolites, body reserves, and feed efficiency of high-producing dairy cows that varied in ruminal pH when fed a high-concentrate diet. *Journal of dairy science*, *102*(1), 672-677.

Nayel, U. A., Fathy, A. A., Kewan, K. Z., & Ali, M. M. (2022). Effect of body weight and concentrate feeding frequency on productive and performance of Barki ewes. *Egyptian Journal of Nutrition and Feeds*, *25*(2), 223-236.

NRC. (2007). *Nutrient Requirements of Small Ruminants. Sheep, Goats, Cervids, and New World Camelids*. National Academy Press.

SAS. (1996). *SAS procedure guide* (Version 6.12 edition). SAS Institute, INC.

Schneider, B. H., & Flatt, W. P. (1975). *The evaluation of feeds through digestibility experiments*. Univ. Georgia Press.

Shetaewi, M. M., & Ross, T. T. (1987). Effect of supplementation with concentrates and lasalocid during late pregnancy and lactation on productivity of Rambouillet ewes and development of wool follicles in their lambs. *Journal of animal science*, *65*(2), 351-358.

Sun, X., Chen, A., Pacheco, D., Hoskin, S. O., & Luo, D. (2019). Sheep rumen fermentation characteristics affected by feeding frequency and feeding level when fed fresh forage. *Animals*, *10*(1), 7.

Taie, H. T. (1996). Digestion kinetics, performance and carcass characteristics of sheep as affected by feeding frequency. *Egyptian J. Anim. Prod.*, *33* (Suppl. Issue), 223-234.

Tripathi, M. K., Santra, A., Chaturvedi, O. H., & Karim, S. A. (2004). Effect of sodium bicarbonate supplementation on ruminal fluid pH, feed intake, nutrient utilization and growth of lambs fed high concentrate diets. *Animal feed science and technology*, *111*(1-4), 27-39.

Van Keulen, J., & Young, B. A. (1977). Evaluation of acid insoluble ash as a natural marker in ruminant digestibility studies. *J. Anim. Sci.*, *44*, 282-287.

Van Soest, P. J. (1994). *Nutritional ecology of the ruminant* (2nd edition). Cornell University Press.

Van Soest, P. J., & Robertson, J. B. (1985). *Analysis of forages and fibrous foods*. Cornell Univ.

Williams, S. R. O., Hannah, M. C., Jacobs, J. L., Wales, W. J., & Moate, P. J. (2019). Volatile fatty acids in ruminal fluid can be used to predict methane yield of dairy cows. *Animals (Basel)*, *9*, 1006.

تأثير تكرار عدد مرات تغذية المركزات على اداء الحيوان و الاستفادة من الغذاء فى نعاج ابودليك الحوامل تحت ظروف منطقة حلايب

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يعتبر استخدام الاعلاف المركزة عامل مهم فى تغذية النعاج الحوامل و لكن التغذية على المركزات مرة واحدة باليوم يمكن ان يؤدى لتأثيرات سلبية على الحيوان مثل حموضة الكرش. و هدفت هذه الدراسة الى معرفة تأثير تكرار عدد مرات تغذية المركزات على المأكول من العلف و قابليته للهضم و وزن ميلاد الحملان لنعاج ابو دليك الحوامل تحت الظروف الجافة لمنطقة حلايب. قسمت ثلاثون نعجة حوامل من سلالة ابودليك فى اخر مرحلة الحمل الى ثلاث مجموعات غذيت جميعا على دريس البرسيم الحجازى صباحا بينما غذيت المجموعة الاولى على علف مركز (قدم على جزئين صباحا و عصرا يوميا) و المجموعة الثانية غذيت على علف مركز (قدم على جزء واحد صباحا يوميا) و المجموعة الثالثة غذيت على علف مركز (قدم على جزء واحد عصرا يوميا). ادى تقسيم العلف المركز الى مرتين يوميا الى تحسن المأكول و كذلك تحسن هضم العلف (بفارق غير معنوى) و تحسن هضم الالياف غير الذائبة فى الحامض (ADFD%) نتيجة زيادة تكرار التغذية على العلف المركز معنويا. انخفض انتاج الميثان فى المجموعة الاولى عن المجموعة الثانية و الثالثة على التوالى و لكن بفارق غير معنوى. كانت قياسات سيرم الدم فى المدى الطبيعى لكل المجموعات. اختلف وزن المواليد من الحملان معنويا بين المجاميع و حققت المجموعة التى تغذت مرتين على العلف المركز اعلى زيادة فى متوسط وزن ميلاد الحملان. يمكن تطبيق ممارسة تكرار عدد مرات التغذية للمركزات لتحسين الاستفادة من الغذاء و زيادة وزن ميلاد الحملان لنعاج ابو دليك الحوامل.

الكلمات الدالة: تكرار التغذية – الاستفادة من الغذاء - انتاج الميثان - وزن الميلاد - اغنام ابودليك - منطقة حلايب