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EFFECT OF FEEDING FREQUENCY OF THREE DIFFERENT ROUGHAGES ON ANIMAL PERFORMANCE IN DIFFERENT SHEEP BREEDS

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ABSTRACT

Three roughages (corn stalks, wheat straw, and rice straw) were compared for the effect of two or three times feeding frequency per day on the performance of three different sheep breeds (Farafra, Chios and Ossimi). Feeds consisted of 50:50 roughage: concentrates and were offered restricted at 3% of live body weight in eighteen metabolism trials.

Dry matter intakes were not influenced by frequency of feeding, animal breed or by type of roughage. Ossimi breed showed higher values than the other breeds in nutrient utilization. Three times feeding frequency showed better digestibility coefficients than two times. Ossimi, corn stalks and three times feeding were higher than the others in nitrogen retention. Results indicated that no significant differences among breeds, type of roughage and feeding frequency in rumen parameters.

It is concluded that, under the conditions prevailed in this study, increasing feeding frequency improved nutrient utilization in different sheep breeds or in different rations.

Keywords: feeding frequency, roughage, sheep, perfromance

INTRODUCTION

Many investigators (Burt and Dunton, 1967; Stanley and Morita, 1967 and Smith *et al*, 1978) have reported that feed intake is not stimulated by offering mixed rations more than once daily. Whole tract nutrient digestion also is not affected (Honing *et al*, 1976 and Robinson and Sniffen, 1985). However, increasing frequency of feeding will lead to less fluctuation of ruminal characteristics and stabilize diurnal rumen fermentation patterns (Nocek and Braund, 1985 and Nocek; 1987). This may, theoretically, increase efficiency of nutrient digestion in the rumen (Johnson, 1976; Gibson, 1981 and Ulyatt *et al*, 1984). This will also enhance maximum microbial yield (Nocek, 1992).

The present work was carried out using three different roughages (corn stalks, wheat straw and rice straw) to investigate the effect of two or three times feedings per day on the performance of sheep breeds (Farafra, Chios, and Ossimi).

MATERIALS AND METHODS

The current experiment was carried out at the experimental unit of the Animal Production Research Institute, Dokki, Cairo. Three different sheep breeds (Farafra, Chios and Ossimi) were used in this study. Six male animals from each breed were selected randomly for the study. Animals within each breed were divided into two groups of three animals each. Animal groups were used repeatedly in metabolism trials to evaluate the

experimental rations. Animals were kept in separate metabolic cages fitted with stainless steel separators. Animal weights were recorded at the beginning and at the end of each experiment. A three-week preliminary period was elapsed before a seven-day collection period. Between experiments, the animals were allowed to rest in pens and adapt to the next treatment for two weeks.

Experimental rations consisted of three roughages (corn stalks, wheat straw and rice straw) and concentrate feed mixture (CFM) (Table 1). Rations were offered in restricted amounts (3% of body weight, divided into 50% CFM and 50% roughage). Diets were given in two equal diets at 12 hrs intervals (6.00 am and 6.00 pm) or three equal diets at 8 hrs intervals (6.00 am, 2.00 pm, and 10.00 pm). Water was available all times. Measures of feed intake, water consumption, feces, and urine were made daily at 6.00 am. On the last day of each period, samples of rumen liquor were collected using stomach tube. The samples were withdrawn just before morning feed and 4, 8, 12, 16, and 20 hrs post feeding. The pH values were immediately recorded. Few drops of standard solution of mercuric chloride were used to stop microbial activity. Some of the rumen liquor was used for VFA's determination.

Samples of feeds, feces, and urine were analyzed according to A.O.A.C. (1990). The pH value was measured immediately after collection by using pH meter. Rumen fluid samples were analyzed for TVFA's by steam distillation (Warner, 1964). The data were analyzed statistically at factorial design using GLM procedures of SAS (1992).

RESULTS

Digestibility coefficients and nutritive values

Average nutrient digestibility coefficients and nutritive value of rations when fed to different ram groups are presented in Table (2). Ossimi and Chios rams performed better than Farafra in all traits. Comparison between roughages revealed that corn stalks had higher quality than rice straw and wheat straw. On the other hand, results in Table (2) indicated that increasing frequency of feeding from two to three times a day did not affect most nutrient digestibility coefficients except for OM, CF, and NFE. However, TDN and DCP increased ($P<0.05$) at 3 times feeding.

Nitrogen metabolism

Nitrogen metabolism data are shown in Table (3). Either breed, type of roughage or feeding frequency did not affect nitrogen intake, digested N and nitrogen balance. However, Ossimi rams had significantly higher digested nitrogen/nitrogen intake than Farafra and Chios groups.

Water utilization

Table (4) shows total water intake, water output, insensible water loss and water intake/dry matter intake. These traits had a slight increment ($P<0.05$) in Farafra rams than Chios and Ossimi rams. On the other hand, these traits were affected significantly ($P<0.05$) by type of roughage (Table 4) with wheat straw being the highest and corn stalks the lowest. Differences between two or three times of feeding did not attain significance.

Table 1. Chemical composition of ration ingredients as fed to sheep.

Itsm	DM %	OM	CP	CF	EE	Ash	NFE	NDF	ADF	ADL	Heml cellulose	Cellulose
		DM basis, %										
Rice straw	83.07	85.11	4.79	36.53	1.34	14.89	42.45	83.83	55.91	10.28	27.72	45.64
Wheat straw	85.33	86.58	4.31	36.81	1.46	13.42	44.0	82.88	54.83	10.18	28.05	44.65
Corn stalks	85.29	88.81	4.57	37.10	1.39	11.19	45.75	78.99	48.83	9.10	30.16	39.73
CFM*	88.30	94.76	15.04	13.59	3.04	5.24	63.09	86.51	21.08	4.01	45.43	17.07

* consists of: 40% undecorticated cotton seed cake, 24% wheat bran, 24% yellow corn, 6% rice bran, 3% molasses, 2% limestone, and 1% common salt

Table 2. Daily intake, digestibilities, and feeding values of the experimental rations.

Item	Daily intake, g/h/d		Digestibility, %									Feeding value %			
	Total	$W^{0.75}$	DM	OM	CP	CF	EE	NFE	NDF	ADF	ADL	Hemi cellulose	Cell ulose	TDN	DCP
Effect of breed	*NS*									*NS*			*NS*		
Farafra	1165.15^{a}	67.05^{a}	57.66^{b}	62.68^{b}	51.70^{b}	51.20^{b}	59.19^{b}	70.50^{b}	56.89^{b}	43.37^{a}	9.20^{a}	70.20^{b}	51.53^{a}	58.78^{b}	5.12^{b}
Chios	1173.78^{a}	67.16^{a}	58.94^{a}	63.72^{a}	51.89^{b}	51.55^{ab}	59.94^{a}	71.67^{a}	57.16^{a}	43.54^{a}	9.29a	70.54^{ab}	51.74^{a}	59.55^{a}	5.13^{ab}
Ossimi	1165.15^{a}	67.10^{a}	59.10^{a}	63.98^{a}	52.59^{a}	51.70^{a}	60.58^{a}	72.03^{a}	57.29^{a}	43.55^{a}	9.39^{a}	70.76^{a}	51.74^{a}	59.87^{a}	5.20^{a}
Effect of type of roughage	*NS*														
Rice straw	1162.45^{a}	66.77^{a}	58.58^{a}	63.37^{a}	52.15^{ab}	51.52^{a}	59.60^{b}	71.17^{b}	56.99^{b}	43.32^{b}	9.33^{a}	70.33^{b}	51.39^{b}	58.82^{b}	5.26^{a}
Wheat straw	1172.83^{a}	67.40^{a}	57.97^{b}	62.37^{c}	51.66^{b}	50.93^{b}	59.44^{b}	70.15^{c}	56.88^{b}	43.21^{b}	9.49^{a}	70.35^{b}	51.45^{b}	58.39^{c}	5.17^{b}
Corn stalks	1168.81^{a}	67.14^{a}	59.12^{a}	84.56^{a}	52.33^{a}	51.97^{a}	60.66^{a}	72.81^{a}	57.48^{a}	43.92a	9.10^{a}	70.82^{a}	52.17^{a}	61.00^{a}	5.00^{c}
Effect of feeding frequency			*NS*												
2 times	1170.21^{a}	67.23^{a}	58.33^{a}	63.22^{b}	51.90^{a}	51.17^{b}	59.69^{a}	71.08^{b}	57.03^{a}	43.43^{a}	9.20^{a}	70.38^{a}	51.64^{a}	59.12^{b}	5.11^{b}
3 times	1165.85^{a}	66.98^{a}	58.80^{a}	63.83^{a}	52.22^{a}	51.80^{a}	60.11^{a}	71.74^{a}	57.20^{a}	43.54^{a}	9.37^{a}	70.62^{a}	51.70^{a}	59.69^{a}	5.18^{a}

a, and b: Means within column for each category bearing different letters differ ($P<0.05$)

Table 3. Nitrogen utilization of sheep fed the experimental rations

Item	N intake	Fecal N	Digested N	Urinary N	N balance	Digested N/intake	Urinary N/Intake	NB/ Intake	NB/ digested N
				g/h/d				%	
Effect of breed			–	*NS*					*NS*
Farafra	18.41	8.89	9.52[a]	7.15[a]	2.37[a]	51.71[b]	38.84[b]	12.87[a]	24.89[a]
Chios	18.55	8.93	9.62[a]	7.23[a]	2.39[a]	51.86[b]	38.98[ab]	12.88[a]	24.84[a]
Ossimi	18.41	8.73	9.68[a]	7.25[a]	2.43[a]	52.58[a]	39.36[a]	13.20[a]	25.10[a]
Effect of roughage type			of *NS*				*NS*		
Rice straw	18.66	8.91	9.75[a]	7.32[a]	2.43[a]	52.25[a]	39.23[a]	13.02[ab]	24.92[ab]
Wheat straw	18.24	8.82	9.42[a]	7.12[a]	2.30[a]	51.64[b]	39.04[a]	12.61[b]	24.42[b]
Corn stalks	18.46	8.80	9.66[a]	7.20[a]	2.46[a]	52.33[a]	39.00[a]	13.33[a]	25.47[a]
Effect of feeding frequency						*NS*			
Two times	18.45	8.87	9.58[a]	7.20[a]	2.38[a]	51.92[a]	39.07[a]	12.90[a]	24.84[a]
Three times	18.45	8.81	9.64[a]	7.22[a]	2.42[a]	52.25[a]	39.13[a]	13.12[a]	25.10[a]

a, and b: Means within column for each category bearing different letters differ (P<0.05)

Table 4. Water utilization (ml/h/day) of sheep fed the experimental rations

Item	Water intake	Feed moisture	Total water intake	Fecal moisture	Urine volume	Total water output	Insensible water	Water intake (l/Kg DM)
Effect of breed		*NS*		*NS*			*NS*	
Farafra	2050.7[a]	184.95[a]	2235.7[a]	442.5[a]	643.2[a]	1085.7[a]	1150.0[a]	1.92[a]
Chios	1989.7[ab]	186.34[a]	2176.1[ab]	421.2[a]	609.2[ab]	1030.4[a b]	1145.7[a]	1.86[a]
Ossimi	1953.2[b]	184.77[a]	2137.9[b]	422.1[a]	552.8[b]	974.8[b]	1163.1[a]	1.84[a]
Effect of type of roughage		*NS*					*NS*	
Rice straw	1992.8[b]	190.94[a]	2183.7[b]	445.3[a]	586.7[b]	1032.0[a b]	1151.7[a]	1.88[ab]
Wheat straw	2094.33[a]	180.56[a]	2274.9[a]	227.9[a]	668.1[a]	1121.8[a]	1153.1[a]	1.94[a]
Corn stalks	1906.5[c]	184.56[a]	2091.1[c]	386.8[c]	550.4[b]	937.2[b]	1153.9[a]	1.79[b]
Effect of feeding frequency						*NS*		
Two times	2033.9[a]	183.15[a]	2217.1[a]	2217.1[a]	618.5[a]	1053.1[a]	1164.0[a]	1.90[a]
Three times	1961.8[b]	187.55[a]	2149.3[a]	2149.3[a]	584.9[a]	1007.5[a]	1141.8[a]	1.85[a]

a, b, and c: Means within column for each category bearing different letters differ (P<0.05)

Ruminal parameters

Ruminal pH and TVFA's at different times (0, 4, 8, 12, 16, and 20 hrs postfeeding) are presented in Table (5) and Figures 1 and 2. Mean values of ruminal pH or TVFA's concentrations were not influenced (P>0.05) by breeds or type of roughage. Noticeably, variations in feeding frequency altered the patterns of rumen fermentation at 0, 8, 12, 16, and 20 hrs postfeeding. Yet, there were no changes in either pH values or TVFA's concentrations between twice and three times feeding a day at the overall means.

DISCUSSION

Rations were offered in restricted amount at 3% of body weight divided into 50% CFM and 50% roughage. Consequently, no significant differences were detected among animal breeds, type of roughage, or feeding frequency concerning either total DM intake (g/h/d) or DM intake as a unit of metabolic

body size (Table 2). This should be expected since rations did not differ dramatically. Rumen capacity does not change rate of passage under similar nutritional conditions. Therefore, total dry matter intake should not be changed when frequency of feeding changed. Coleman *et al.* (1984) found that voluntary DM intake was not changed by increasing the number of meals from once to twice a day or up to four times a day (Gill and Castle, 1983 and Goouewardene *et al.*, 1995).

In Table (2) corn stalks had a little higher quality than rice straw or wheat straw. This can be attributed to high content of OM and hemicellulose and low content of ash, cellulose, and lignin in corn stalks than in other roughages (Table 1). These results are similar to those obtained by Fouad 1991, 1995 and Fouad *et al.* (1998) and Fahmy *et al.* (1994). Attia-Ismail *et al.*(1994) reported that corn stalks had significantly higher digestibility values of DM, OM, CP, and cellulose than rice straw, wheat straw, barley straw and bean straw. On the other side, increasing feeding frequency increased digestibility coefficients of OM, CF, and NFE. It, further, increased feeding values (TDN and DCP) significantly.

The results are in agreement with those obtained by many investigators. Ruiz and Mowat, (1987) obtained small increments in DM and OM digestibility when feeding frequency increased from two to three times. Clark and Keener, (1962) and Ikhatna and Adu (1985) reported that nutrient digestibility tended to increase when feeding frequency increased on either ad lib or restricted basis. However, Stanlon *et al.* (1990) reported that feeding frequency did not affect the digestibility of nutrients. Ikhatn *et al.* (1987) found no significant differences between twice and three times of feeding a day.

In Table (2) increasing the frequency of feeding from two to three times increased CF digestibility. This may be due to more uniform rumen fermentation (French and Kennelly, 1984), resulting in increased fiber digestion (Robinson and Sniffen, 1985). On the other hand, Howard *et al.* (1992) found that increased feeding frequency improved protein synthesis. Consequently, improved efficiency of food utilization (Gibson, 1981). Moreover, Taei (1996) found that the values of TDN and DCP were improved with increasing feeding frequency.

The results (Table 3) indicated that nitrogen retention (NR, g/h/d), digested N and NR as a percent of N intake and NR as a percent of digested N were higher with Ossimi groups, corn stalks fed groups and three times feedings a day. The increase in nitrogen metabolism may have been due to the improvement of nutrient digestibilities (Table 2). This may have led to higher microbial protein synthesis (Taei, 1998). Ruiz *et al.* (1989) found that feeding frequency improved ($P<0.05$) nitrogen retention. Abdel-Aziz *et al.* (1993) found that corn stalks fed group had higher N retention than rice straw fed group of sheep.The present study was carried out at wintertime. Therefore, the differences in either water intake or excretion did not seem to be significant. There was no heat load to affect water intake or even to magnify the differences in water intake as related to type of roughage.

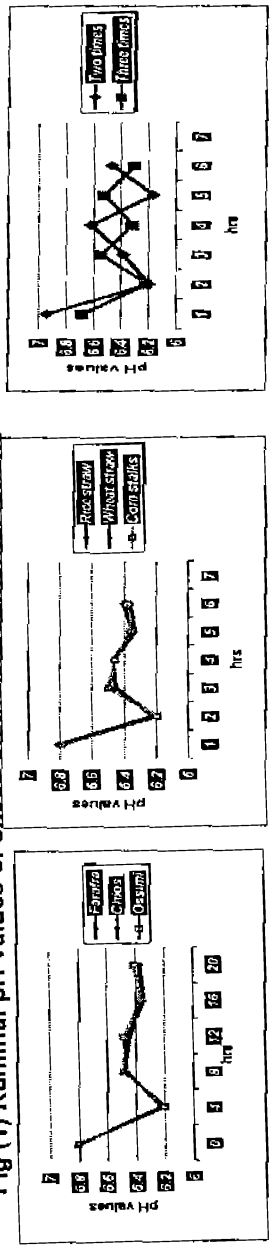

Fig (1) Ruminal pH values of sheep on the experimental rations

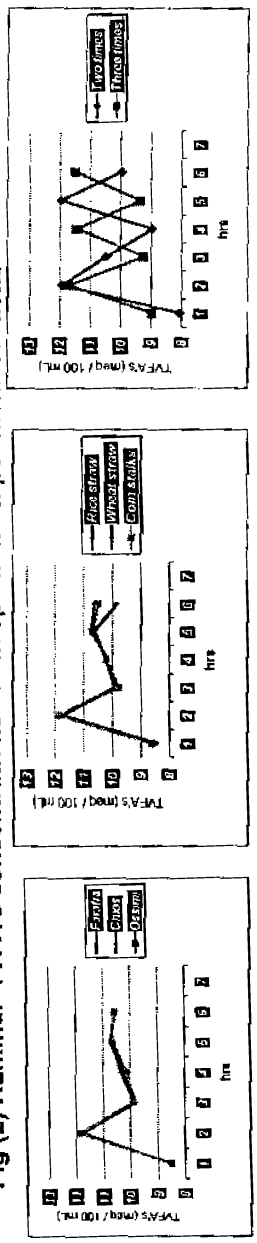

Fig (2) Ruminal TVFA's concentrations of sheep on the experimental rations

Table 5. Effect of the experimental rations on ruminal pH and TVFA's of sheep at different sampling times

Item	pH							TVFA's, meq/100 ml						
	0	4	8	12	16	20	Ave.	0	4	8	12	16	20	Ave.
Effect of breed		***NS***						***NS***						
Farafra	6.81[a]	6.21[a]	6.48[a]	6.44[a]	6.35[a]	6.38[a]	6.45[a]	8.54[a]	11.84[a]	9.85[a]	10.33[a]	10.65[a]	10.57[a]	10.30[a]
Chios	6.80[a]	6.23[a]	6.47[a]	6.47[a]	6.34[a]	6.37[a]	6.45[a]	8.53[a]	11.80[a]	9.84[a]	10.18[a]	10.73[a]	10.55[a]	10.27[a]
Ossimi	6.81[a]	6.20[a]	6.49[a]	6.49[a]	6.36[a]	6.41[a]	6.46[a]	8.52[a]	11.89[a]	9.89[a]	10.12[a]	10.65[a]	10.56[a]	10.27[a]
Effect of type of roughage			***NS***					***NS***						
Rice straw	6.82[a]	6.21[a]	6.46[a]	6.47[a]	6.35[a]	6.41[a]	6.45[a]	8.50[a]	11.81[a]	9.90[a]	10.22[a]	10.63[a]	9.86[a]	10.15[a]
Wheat straw	6.82[a]	6.23[a]	6.45[a]	6.47[a]	6.33[a]	6.36[a]	6.44[a]	8.46[a]	11.79[a]	9.89[a]	10.19[a]	10.72[a]	10.64[a]	10.28[a]
Corn stalks	6.79[a]	6.19[a]	6.50[a]	6.46[a]	6.36[a]	6.38[a]	6.45[a]	8.62[a]	11.93[a]	9.80[a]	10.22[a]	10.69[a]	10.51[a]	10.30[a]
Effect of feeding frequency			***NS***				***NS***		***NS***					
Two times	6.94[a]	6.20[a]	6.39[b]	6.62[a]	6.17[b]	6.47[a]	6.47[a]	8.08[b]	11.95[a]	10.49[a]	8.96[b]	11.98[a]	9.58[b]	10.17[a]
Three times	6.68[b]	6.22[a]	6.55[a]	6.32[b]	6.52[a]	6.30[b]	6.43[a]	8.97[a]	11.74[a]	9.23[b]	11.46[a]	9.38[b]	11.52[a]	10.38[a]

a, and b: Means within column for each category bearing different letters differ (P<0.05)

However, the results obtained in this study are in agreement with NRC (1981) which reported that sheep consumed about 2 liters of water/Kg DM intake at temperature between zero and 15 °C. Blaxter *et al*, (1959) showed that the urine volume of sheep decreased at cold temperatures. Nocek and Braund, (1985) and Taei, (1996) reported that mean daily voluntary water intake was not significantly influenced by feed frequency (1, 2, 4, and 8 times a day) (Table 4).

Ruminal activity (Table 5) as affected by feeding frequency was tested by the changes in pH values and TVFA's concentrations. Ruminal pH values were higher for all groups before feeding; being on the average 6.81 then decreased steadily to reach their lowest values at 4 hrs then increased at 8 hrs post feeding. Other increase of pH was noticed at 12 hrs post feeding for two times feeding and steadily decreased at 16 hrs and then increased. While the pH values started to decline at 12 hrs with three times feeding, it steadily decreased at 16 hrs, then declined at 20 hrs post feeding.

The decrease in pH values after 4 hrs post feeding was for two and three times feeding, at 16 hrs for two times and 12 and 20 hrs for three times coincided with the two feeding times. Similar trend was observed by Lardy *et al.* (1993); Taei (1993) and Baraghit *et al.* (1995).

The TVFA's concentration was negatively associated with pH values. The TVFA's concentrations fluctuated by sampling time and time of feeding. Similar findings were reported by Giacomini et *al.* (1985) and Burrin and Britton (1986). They indicated that the progress of increasing ruminal TVFA's concentrations paralleled reduction in ruminal pH.

Generally, mean values of pH, or TVFA's concentrations were not influenced significantly by breeds, type of roughage or frequency of feeding. French and Kennelly, (1990) reported that means of ruminal pH were not influenced by feeding frequency. Nevel· *et al.* (1986) found that with increasing feeding frequency, the rumen fermentation pattern became more stable. Kanfmann (1976) reported that ruminal pH was not affected before feeding, but ruminal pH and TVFA's concentrations were significantly affected by time after feeding. At last, the recorded pH values were within the reported range for normally functioning rumen; being 6 to 7 for optimum microoganisms activity (Mertens, 1979).

Depending on this study, it has been found out that the performance of sheep gets better with the increase in number of feeding times depending on the better harmony in rumen fermentation. However, this is independent of the breed of sheep or the bulk material.

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تأثير تكرار التغذية لثلاثة أنواع من المواد الخشنة على أداء سلالات مختلفة مـــن الأغنام

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تم دراسة استخدام ثلاثة أنواع من المواد الخشنة (حطب ذرة - تبن قمح - قش أرز) فى تجـــارب تمثيل غذائى على ثلاثة سلالات مختلفة من الأغنام (فرافرة - كيوس - اوسيمى) وذلك بنظامى التغذية علـــى مرتين أو ثلاث مرات يوميا.

استخدم فى هذه الدراسة ثمانية عشر كبشا وزن ٤٥ كيلوجرام (ستة كباش لكل سلالة) فى إجـــراء ثمانية عشر تجربة تمثيل غذائى وقدم الغذاء بنسبة محددة ٣% من وزن الجسم وكانت العلائق تتكـــون مـــن ٥٠% علف مركز و ٥٠% مادة خشنة.

النتائج أوضحت أن المتناول من الغذاء لم يتأثر بنوع السلالة أو المادة الخشـــنة. الاوســـيمى كـــان الأفضل فى معاملات الهضم واحتجاز النيتروجين والقيم الغذائية، بينما كان حطب الذرة هو الأفضـــل عنـــد مقارنة المواد الخشنة، بينما كان بزيادة مرات تقديم الغذاء من مرتين الى ثلاث مرات يوميا ذات اثر ايجـــابى على معاملات الهضم والقيم الغذائية وميزان الأزوت ولكن لم يلاحظ فروق جوهرية فـــى قياســـات الكـــرش سواء الأس الهيدروجينى أو مجموع الأحماض الدهنية الطيارة سواء فى اختلاف السلالة أو نوعيـــة المـــادة الخشنة المستخدمة أو تكرار تناول الغذاء

وبالتالى وفى ظروف هذه الدراسة نجد أن زيادة عدد مرات تناول الحيوان لغذائه يوميـــا ذات أثـــر جيد على الاستفادة من مكونات العليقة مهما كان نوع سلالة الحيوان أو طبيعة المادة الخشنة المتناوله