Egyptian J. Anim. Prod.(1993) 30 (2):251-262.

EFFECT OF DIETARY PROTEIN LEVEL ON NUTRIENT UTILIZATION, RUMEN FERMENTATION AND COMPOSITION OF BODY CHANGE OF RAHMANI SHEEP AND ZARAIBI GOATS

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SUMMARY

Five yearling male Rahmani and five male Zaraibi goats were used to evaluate their response to the change in dietary protein from 15 to 8%. Feeding low protein diet decreased (P<.05) crude fiber and (P<.01) crude Protein digestibilities. No significant species effect on nutrient digestibilities was detected. Animals just maintained their body weight with marginal gain on low protein diet being 3.6 and 10.6 g/day for goats and sheep respectively. However, sheep gained weigh almost two times more than goats (128.6 vs 60.7 g/day) on the high protein diet. A module to predict the daily gain in sheep and goats as a function from DCP% in the diet was:

$Y= - 28.46 + 7.62 x$ (P=.0033, r=.83)...... Goats.
$Y= - 56.04 + 15.81 x$ (P=.0010, r=.87)...... Sheep.

Feeding low protein diet decreased (P<.01) VFA's and ammonia-nitrogen concentration, molar proportion of acetate but increased (P<.01) ruminal pH and propionate. Sheep showed almost comparable rumen parameters to goats, except the higher (P<.01) VFA's. Body gain composition of sheep was different than that of goats. Goats gained more fat and less water and consequently higher energy on the high protein diet. Therefore, body

RESULTS AND DISCUSSION

Experiment (1): <u>In</u> <u>Vitro</u> work:

Results concerning (IVDMD) and (IVOMD) of different combinations of concentrate feed mixture, leucaena hay, berseem hay and rice straw are shown in Table (2) and Fig.(1). It is found that IVDMD values of the different combinations containing from 0 to 60% leucaena hay were nearly similar (Table 2), they ranged between 49.9 to 52.5%. However, the mixture containing 70% leucaena hay showed the highest value of IVDMD (54%). Data of table (2) showed approximately similar values of IVOMD for mixtures containing from 10 to 60% leucaena hay. However, it is of interest to notice that the lowest and highest values of IVOMD were recorded for mixtures containing 0 and 70% leucaena hay, resp. Differences between the different combinations were not significant neither for IVDMD not IVOMD. Similar results have been reported by Abo EL-Nor,(1987) who found that the mixture of 75% leucaena forage +25% concentrate feed mixture showed higher IVOMD value (53.7%), than those of the mixtures of leucaena forage and concentrate feed mixture at ratios of 50:50% (41.8%)o 25:75% (41.9%),resp

The present results indicate also that there were positive associative effects in IVDMD and IVOMD of the different combinations used except for those containing 0 to 10% leucaena hay which showed negative associative effects (Table 2) .

Results of Table(2) indicated that IVDMD and IVODM values of 100% leucaena hay were better than those of 100% berseem hay or 100% rice straw. This result may be explained on the basis of the higher protein content of leucaena than that of both berseem hay and rice straw. The lower values of IVDMD and IVOMD for 100% leucaena hay than 100% concentrate feed mixture may probably be due to the influence of tannic acid found in leucaena as antinutritional factor on the degradability of leucaena hay (Jones, 1979 and Gupta and Chopra, 1985). Similar results have been reported by Abo El-Nor (1987), who found that IVDMD and IVOMD values of the concentrate feed mixture were greater than those of leucaena forage (71.7 and 68.0% vs. 44.7 and 40.5%). He also found that values of IVDMD and IVOMD of berseem hay were somewhat lower than those of leucaena forage being 37.0 and 28.5%, respectively.

and fed the high protein diet for 8 weeks followed by the low protein diet for another 8 weeks at the rate of 3 Kg DM per 100 Kg body weight which was weekly recorded. Fresh water was freely available.Animals were housed in metabolism cages during the last two weeks of each period. Feces were totally collected during the last week to determine the nutrient digestibilities. Ingredients and chemical composition of the diets are shown in Table 1. Rumen Fluid was sampled during the last two days of each experiment using a stomach tube at 0, 2, 4 and 6 hr after feeding. Rumen pH was immediately measured. Rumen total VFA's (Kromman et al. 1967), ammonia nitrogen (Conway, 1962) and molar proportions of acetate, propionate and butyrate (Erwin et al., 1961) were determined. Body composition was determined using Tritiated water-space technique by the extrapolation method as followed by El-Badawi et al. (1991). Chemical composition of diets and feces was determined according to A.O.A.C.(1980). Data collected were analyzed using two-way analysis of variance. Duncan multiple rang test were applied if the main effects were significant.The relationship between dietary protein percentage and daily gain in weight were tested using simple linear regression module (SAS,1986).

Table 1. Composition of experimental diets.

Composition	Protein level	
	High	Low
Ingredient (%)		
Berseem hay	25.00	--
Rice Straw	--	25.00
Barley grain	59.60	73.00
Soybean meal	13.40	--
Limestone	0.88	0.88
Common Salt	1.00	1.00
AD3 E premix	0.10	0.10
Trace mineral premix	0.02	0.02
Dry matter (%)	89.91	93.29
Dry matter composition, %		
Organic matter	90.88	92.40
Crude protein	14.86	8.03
Crude fiber	17.37	16.56
Ether extract	2.18	1.48
Nitrogen free extract	56.47	66.33
Ash	9.12	7.60

RESULTS AND DISCUSSION

Nutrient digestibilities and nutritive of the experimental diets are Shown in Table 2. Goats showed almost similar digestive capacity as sheep. Low dietary protein level reduced (P<.05) crude fiber and (P<0.01) crude protein digestibilities. This might indicate that the low protein level (4.5% DCP) was not adequate for cellulolytic microorganism although this level provided a minimum of 17 mg ammonia nitrogen/100 ml in the rumen liquor (Table 4) which is greater than 5 mg/100 ml reported by Satter and Slyter (1974) to give optimum microbial yield /unit substrate fermented but lower than 23.5 mg/100 ml for a concentrate diet (Mehrez et al. 1977). Moreover, the deficient protein feedstuffs such as rice straw and barley grains are not only low in CP content but they are also of poor protein quality.

Table 2. Apparent nutrient digestibilities and nutritive values of high and low protein diets by goats and sheep.

Species	Digestibilities (%)						Nutritive value	
	DM	OM	CP	CF	EE	NFE	TDN	DCP
			High protein diet					
Goats	76.08	77.73	78.94a	59.70e	69.01	83.54	71.90	11.76a
Sheep	75.47	77.42	79.32a	59.65e	66.42	83.87	71.86	11.75a
			Low protein diet					
Goats	74.00	76.42	56.57b	53.32f	67.56	82.86	71.55	4.28b
Sheep	72.01	75.03	58.42b	51.81f	65.69	80.52	70.54	4.16b
SEM	2.31	2.08	3.64	4.58	3.77	1.59	2.42	0.36

[a,b] Means in the same column bearing different superscripts differ (P< .01).
[e,f] Means in the same column bearing different superscripts differ (P< .05).

Feed intake and body weight change are presented in Table 3. Animals just maintained their body weight with marginal daily gain on low protein diet, while sheep gained weight almost two times more than goats on high protein diet (128.6 vs 60.7 g/day).

The NRC (1981) maintenance requirements for goats with an average body weight of 21.1 Kg are 266 g TDN and 26.8 g Dcp. Subtracting these values from the corresponding intake of goats on high protein diet (413 g TDN and 68.0 g DCP), the excess is then for the daily gain of goats (60.7 g/day) will be 147 g TDN and 41.2 g DCP i.e 242 g TDN and 68 g DCP per 100 g daily gain. These values represented about 120% of TDN and 205% of DCP recommended by NRC (1981). Lu and Potchoiba (1990) used the same approach, utilizing the NRC-maintenance requirement to calculate the requirement of ME for Growth in goats which was found to be 33% lower than of NRC (1981).

Table 3. Feed intake and body weight of goats and sheep fed high and low protein diets.

Item	High protein		Low protein		SEM
	Goats	Sheep	Goats	Sheep	
Initial Weight, Kg	18.4a	29.8b	21.8a	37.0b	1.8
Final Weight, Kg	21.8a	37.0b	22.0a	37.6b	1.8
Gain, Kg	3.4b	7.2c	0.2a	0.6a	0.5
Daily gain, g/day	60.7b	128.6c	3.6a	10.6a	9.2
DM intake, g/day:					
Roughage	143a	239b	176a	260b	13
Concentrate	431a	718b	493a	805b	43
Total	574a	957b	669a	1065b	52
Nutrient intake, g/day					
TDN	412.7a	687.7b	478.7a	751.3b	11.2
DCP	67.5a	112.5b	28.6c	44.3c	4.3

a,b,c Means in the same column bearing different superscripts differ (P< .01).

Similarly the NRC (1975) maintenance requirements for sheep with an average body weight of 33.4 kg are 375g TDN and 44.7 g DCP. Subtracting these values from the intake (688 g TDN and 113 g DCP), the excess for the daily gain of sheep (128.6 g/day) would be 313 g TDN and 68.0 g DCP i.e 243 g TDN and 60 g DCP per 100 g daily gain. These values represented 170% of TDN and 230% of DCP recommended by NRC 1975.

Applying the previous approach for goats and sheep fed the low protein diet, the expected daily gain according to the energy intake will be 81 g/day in goats and 142 g/day for sheep but the actual daily gain was 3.6 g for goats and 10.6 g for sheep. The difference between the expected and the actual gain is a result of the severe deficient protein intake provided by feeding the low protein diet (4.2%).Therefore, feeding adequate energy is a waste when protein intake is not sufficient and protein intake is a limiting factor for the weight gain of yearling sheep and goats.

The relationship between DCP% in the diet ranging, from 4.2 to 11.75% and the average daily gain was found to be linear, and an equation based on 10 observations for each species, was predicted as follow:

$Y= -28.46 + 7.62 X$ (P=.0033, r=.83) ..... Goats

$Y= -56.04 + 15.81 X$ (P=.0010, r=.87) ..... Sheep

where Y= daily gain (g/day) and X =DCP% in the diet.

This module could provide an indication about the DCP maintenance requirement of goats and sheep. The maintenance (Y=0) will be achieved by feeding diets containing 3.73% DCP to goats and 3.55% DCP to sheep at the rate of 3 Kg DM/ 100 Kg body weight provided that energy requirements are met. These percentages are equivalent to the values for goats and sheep of resp., 2.4 and 2.6 g DCP / Kg $W^{0.75}$, which is comparable to that recommended for maintenance by NRC (1981) for goats and NRC (1975) for sheep. Although, the maintenance DCP requirement was close to that recommended by NRC (1975, 1981) for both species, yet it was clear that DCP requirement for growth by local breeds of goats and sheep is higher than that of NRC-standards.

The module might also indicate the higher response of weight gain of sheep to the DCP% in the diet than goats, where the regression coefficient of DCP% was 7.62 for goats and 15.81 for sheep i.e to achieve 100 g daily gain in weight, diet of goats should contain 16.86 % DCP while a 9.87% DCP in the diet sheep will be sufficient. In other words, if both species are fed diet containing 9.87% DCP, then the expected daily gain of goats will grow at rate of 47 g/day but sheep will grow at rate of 100 g daily.

Ruminal pH, VFA's and ammonia-N are presented in Table 4. Total VFA's concentration increased ($P<.01$) by feeding high protein diet. Sheep showed higher ($P<.01$) values than goats, especially on high protein diet where the diet x species interaction was found to be significant ($P<0.01$). No significant interaction was observed between species and time or between diet and time. However, the concentration at 0 and 6 hr after feeding showed the lowest value.

Ammonia nitrogen concentration was higher ($P<.01$) when high protein diet was fed. No significant difference was detected between goats and sheep. Ammonia concentrations reached their peak values at 2 hr. Post-feeding for goats and sheep fed high protein diet. However, no effect due the sampling time was detected when low protein diet was fed.

Table 4. Rumenal pH, ammonia-nitrogen and total volatile fatty acids concentrations by goats and sheep fed high or low protein diets.

	High protein		Low protein		
	Goats	Sheep	Goats	Sheep	
		pH			
Before feeding	6.39bcd	6.13de	6.42bcd	6.83a	
2hr. post-feeding	6.33bcde	6.33bcde	6.40bcd	6.63abc	
4hr. post-feeding	6.39bcd	6.25bcde	6.23bcde	6.65ab	
6hr. post-feeding	6.21cde	5.96e	6.13de	6.40bcd	0.13
		Ammonia-N			
Before feeding	38.96ab	30.64bc	20.99de	18.89de	
2hr. post-feeding	43.83a	36.32ab	17.99de	18.09de	
4hr. post-feeding	31.25bc	25.97cde	16.99e	21.59de	
6hr. post-feeding	22.73cde	26.58cd	16.99e	17.09e	2.82
		VFA'S			
Before feeding	4.22f	9.19b	5.60def	3.96f	
2hr. post-feeding	6.66de	11.08a	5.70def	3.96ef	
4hr. post-feeding	7.18cd	9.51ab	5.78def	6.59de	
6hr. post-feeding	5.28ef	8.75bc	5.50def	5.29ef	0.56

a,b,c,d,e,f Means within each trait bearing different superscripts differ (P<.01).

No significant difference between goats and sheep in ruminal pH was detected. Feeding high protein diet resulted in (P<.01) lower pH. Ruminal pH decreased as sampling time post-feeding advanced.

Feeding high protein diet increased (P<.01) the molar proportion of acetate; decreased (P<.01) propionate, which was reflected on higher acetate: propionate ratio (Table 5), while molar proportion of butyrate had not been significantly affected by dietary protein level. No significant difference was detected between goats and sheep in the molar proportions of ruminal volatile fatty acids. Sampling time had no significant effect on the molar proportions of acetate, propionate and acetate: propionate ratio. While butyrate concentration before feeding was lower (P<.01) than that post feeding.

The higher ruminal VFA's ammonia concentrations and lower pH by animals fed high protein diets in this study might indicate the higher levels of microbial activity (Haaland et al. 1982). A close inverse relationship (r = - .87) between rumen pH and concentrations of total VFA's was found, on the other hand, no correlation was found between ruminal pH and ammonia nitrogen. This might indicate that ruminal pH was dependent on VFA's more than ammonia concentrations. However, higher ruminal ammonia-N may be associated with the higher nitrogen digestibility for the high protein diets (de Faria and Huber 1984) and faster rate of rumen fermentation (Mehrez et al. 1977).

Table 5. Molar proportions of rumen volatile fatty acids by goats and sheep fed high or low protein diets.

Sampling time	High protein		Low protein		SEM
	Goats	Sheep	Goats	Sheep	
	Acetate, (%)				
Before feeding	59.25ab	54.50abcde	48.91cde	47.61de	
2hr. post-feeding	58.81ab	58.43abc	45.75e	53.77abcde	
4hr. post-feeding	63.50abc	56.08abcd	46.77de	52.35abcde	
6hr. post-feeding	61.58a	52.30abdce	47.64de	51.11bcde	4.15
	Propionate,(%)				
Before feeding	26.51abcd	21.80d	27.40abcd	31.91abc	
2hr. post-feeding	27.07abcd	26.03abcd	34.65a	30.82abcd	
4hr. post-feeding	23.59bcd	23.13cd	33.56a	33.16ab	
6hr. post-feeding	23.84bcd	25.24abcd	33.15ab	30.99abcd	4.03
	Butyrate, (%)				
Before feeding	14.23cd	23.70a	23.60a	20.47abc	
2hr. post-feeding	14.13cd	15.53bcd	19.60abc	15.41bcd	
4hr. post-feeding	12.91d	20.79ab	19.68abc	14.49bcd	
6hr. post-feeding	15.25bcd	22.47a	19.20abcd	17.90abcd	2.74
	Acetate :propionate ratio				
Before feeding	2.30abcde	2.94a	1.91abcde	1.57.de	
2hr. post-feeding	2.29abcde	2.29abcde	1.40e	1.81bcde	
4hr. post-feeding	2.74ab	2.54abcd	1.45e	1.66cde	
6hr. post-feeding	2.67abc	2.15abcde	1.59de	1.78bcde	0.58

a,b,c,d,e,f Means within each trait bearing different superscripts differ (P<.01).

Changes in body components are shown in Table 6. During 56 days goats and sheep fed high protein diets gained 3.4 and 7.2 Kg. The composition of the gain is extremely different between the two species. On the high protein diet, body gain of goats composed of 44% water, 40% fat, 12% protein and 4% ash. The corresponding percentages recorded for sheep were 65, 12, 18 and 5%. The results indicate the lower water and higher fat of goat's gain than that of sheep. Bearing the calorific value of stored fat as 9.5 Mcal/kg and 5.7 Mcal/Kg protein (Kleiber, 1961), the calorific value of 1 Kg gain in goats would be about 4.5 vs 2.2 Mcal for sheep. This difference in calorific value may explain the low efficiency of goats in comparison with sheep when the efficiency is calculated as a function of daily gain in weight and daily feed intake. In such comparative studies, body change composition should be considered.

Table 6. Change in body components of goats and sheep fed high or low protein diets.

Component, Kg	High protein		Low protein		
	Goats	Sheep	Goats	Sheep	SEM
Gain kg	3.400b	7.236	.200a	.638a	.500
Water	1.498b	4.685a	-.072c	.677bc	.593
Fat	1.370	.830	.298	-.344	1.004
Protein	.413b	1.317a	-.020c	.190bc	.165
Ash	.119b	.404a	-.006b	.102b	.062

a,b,c Means in the same raw with different letters differ (P<.01).

Feeding low protein diet caused a sever depression in weight gain in both species. The figures in Table 6 indicated that the term of average daily weight gain is misleading term because it is a resultant of positive and negative changes in body components. e.g. while the gain recorded for sheep was 600 g during the experimental period, sheep lost fat and gained water, protein and ash. On the other hand, goats gained 200 g as a resultant of loss in water, protein, ash and gain in fat. The experiments to investigate the effect of plane of nutrition on the actual weight of body components at any given body weight have produced conflicting results. Searle et al. (1972) found that sheep had more 11% fat when fed ad lib. that sheep fed half of this level. Burton and Reid (1969) found no effect of nutrition during gain compared with that during maintaining weight in weight. Andrews and Orskov (1970) found that increasing intake of diet containing 15, 17.5 or 20 % CP increased body content of fat and decreased protein. However, at the lowest protein level (10%) the reverse occurred. Moreover, Searle et al. (1982) found no effect of plane of nutrition on protein content of empty body while, the animals that grew slowly had more fat, energy and ash and less water at any given empty body weight than those grew rapidly.

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تأثير مستوى بروتين العليقة على الاستفادة الغذائية والتخمر فى الكرش وتركيب التغير فى جسم كل من الغنم الرحمانى والماعز الزرايبى

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تم فى هذه الدراسة استخدام خمسة ذكور من كل من الغنم الرحمانى والماعز الزرايبي وقد غذيت الحيوانات على عليقة احتوت على ١٥٪ بروتين خام ثم تم نقل الحيوانات على عليقة انخفضت بها نسب البروتين الخام الى ٨٪ وقد اوضحت النتائج ان التغذية على العليقة منخفضة البروتين تخفض هضم الالياف (٠,٠٥) وهضم البروتين (٠,٠١) ، ولم يكن هناك فرق بين نوعى الحيوانات من حيث معاملات هضم المواد الغذائية المختلفة . كانت معدلات الزيادة الوزنية للاغنام تقارب ضعفت الزيادة الوزنية للماعز (١٢٨,٦ جم يوم مقابل ٦٠.٧ جم / يوم) وذلك عند التغذية على العليقة المرتفعة البروتين ، بينما كانت الزيادة الوزنية هامشية لكل من الماعز والاغنام عند التغذية على العليقة منخفضة البروتين (٣,٦ جم / يوم للماعز ، ١٠,٦ جم / يوم للاغنام). وقد أمكن استنتاج معادلتى تنبؤ لمعدلات الزيادة اليومية لكل من الماعز والاغنام بمعلومية نسبة البروتين المهضوم فى العليقة وهى كما يلى :

الزيادة الوزنية اليومية للماعز = - ٢٨,٤٦ + ٧,٦٢ × نسبة البروتين (معامل ارتباط = ٠,٨٣)

الزيادة الوزنية اليومية للاغنام = - ٥٦,٠٤ + ١٥,٨١ × نسبة البروتين (معامل ارتباط = ٠,٨٧)

ان التغذية على العليقة منخفضة البروتين تسببت فى خفض تركيز كل من الاحماض الدهنية الطيارة والامونيا فى الكرش (٠,٠١) كما انخفضت (٠,٠١) نسبة الاسيتات بينما ارتفعت (٠,٠١) كل من نسبة البروبيونات ورقم حموضة الكرش • وقد ظهر التقارب بين نوعى الحيوانات فيما يتعلق بقياسات سائل الكرش باستثناء ارتفاع محتوى كرش الاغنام من الاحماض الدهنية الطيارة الكلية مقارنة بالماعز .

كانت الزيادة الوزنية للماعز عند التغذية على العليقة مرتفعة البروتين متميزة بارتفاع نسبة محتواها من الدهن وانخفاض محتواها من الماء وبالتالى ارتفاع محتوى الزيادة الوزنية من الطاقة ، وعلى ذلك فان معرفة مكونات الزيادة الوزنية تكون ذات أهمية عند تلك الدراسات المقارنة بين الانواع .