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Different Energy and Protein Levels in Rations for Fattening Lambs

1. Effect of Different Energy and Protein Levels in Rations on Body Weight Gain and Feed Efficiency of Rahmani Lambs

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Fifty four Rahmani lambs, approximately 4-5 month old, with an average body weight of about 22 kg were used in this study. Three levels of energy and three levels of protein were involved in a factorial design, that allowed the determination of the allowances of energy and protein separate or combined. The level of energy and protein recommended by Morrison (1959) for fattening growing lambs was used as the reference ration. Animals were grouped randomly into nine experimental treatments. Gain in body weight and feed efficiency were determined twice throughout the experimental period. The first after the experiment had extended for 132 days from the beginning of the trial until the average body weight of lamb group maintained on the reference level reached the weight of about 45 kg for second was determined at the end of the entire experimental period (236 days). Results indicated that increasing the energy level within each of the protein levels used significantly affected the daily gain. However, the feed efficiency was decreased as the energy level increased. Better feed efficiency was observed for groups fed low energy diets. Dry matter, N.F.E., C.F. and protein digestability was significantly affected by energy level.

The poor growth and development of endogenous lambs during their first year of life has frequently noticed. Such growth restrictions commonly resulted in a delay to reach the optimum live body weight for marketing surplus male lambs. Under Egyptian conditions, the prolonged periods of summer undernutrition which commonly follow weaning is responsible for growth retardation.

It is well accepted that improving the animal performance is more effective than increasing their number particularly when feeding stuffs are not abundant.

To increase meat production requires detailed information on the influence of factors affecting their growth ; however, there are no quantitative data on the changes in body energy and body weight of the endogenous breeds during the period from weaning up to maturity. The main objective of this work is the investigation of the most economic levels of energy and protein in rations for fattening lambs.

Material and Methods

Fifty four Rahmany lambs produced in Serw experimental station Ministry of Agriculture, were included in this study. The animals were 4-5 months old. For a period of two weeks, they received a daily ration of Berseem (Egyptian clover) and a feed mixture consisting of ground barley, corn and co-op feed mix.

Animals were distributed according to body weight to nine experimental groups of six lambs each. The average initial live weight of each group was approximately 22 kg.

Three levels of energy expressed as T.D.N. or starch equivalent (S.E.) and other three levels of digestable protein (D.P.) were included in this study. The level of energy or protein was that recommended by Morrison (1959) for the growing fattening lambs, made a base and was also considered as a medium level.

The high level of energy or protein was 125% of the medium level, while the low level of each was 75% of the medium level.

Accordingly the different nine combinations were distributed in a (3^2) three by three factorial arrangement. Animal groups were randomly assigned to the nine combinations of levels (treatments).

Ingredients used to formulate the nine experimental rations were ground barley, corn, co-op feed mix, clover hay and clover straw. In order to adjust the experimental rations according to the differences in their energy and protein contents, proportions, of ingredients in each ration varied to some extent. In cases of high energy rations, proportions of barley, corn and clover straw were increased on the expense of co-op feed mix and clover hay. This was reversed in cases of high protein rations. Consequently, the roughage to concentrate ratio which has been kept at a level of 50:50 (on dry matter basis) until the control animals reached an average live body weight of 45 kg, this ratio was changed to a level of 25:75 at the later period. Adequate supplements of mineral and vitamin mixtures were added to all ration. Food and water were offered twice daily at 8 a.m. and 3 p.m.

Throughout the experimental period, body weight were recorded weekly and the amount of feeds were changing according to body weight, categories (Morrison 1959). Gain in body weight and feed efficiencies were estimated at two periods. The first period extended 139 days until the animals of the control group reached approximately an average of 45 kg live weight. The second period was the entire experimental period (236 days) at which the control animals reached approximately 56 kg live weight.

Factorial arrangement of the different nine treatments according to energy

Energy level	Protein level	Nutritive ratio
High (HE) . .	High (HP) . .	1 : 8.53
	Medium (MP) .	1 : 10.5
	Low (LP) . . .	1 : 11.85
Medium (ME) .	High (HP) . . .	1 : 6.64
	Medium (MP) *	1 : 8.46
	Low (LP) . . .	1 : 10.47
Low (LE) . . .	High (HP) . .	1 : 4.48
	Medium (MP) .	1:5.68
	Low (LP) . .	1:8.42

* Treatment of medium energy medium protein (ME-MP) served as a control.

Two animals of each group were subjected to digestion and nitrogen balance trials at the weight of 34-40 kg live weight. Feed intake through this period was calculated by substracting the residues which were left in front of the animals after it has been chemically analysed.

Statistical analysis was carried out according to (Snedecor, 1967).

Results

The results of average daily gain, feed efficiency and protein efficiency of the different experimental groups are presented in Table I. It is obvious that the highest daily gain was that for group of lambs fed high energy-high protein level (HE-HP), followed by those on the high energy-medium protein, while the lowest daily gain was obtained by lambs kept on the low energy - low protein level (LE-LP).

Efficiency of feed utilization was highest for the group of lambs fed the low energy - high protein level (LE-HP), while lambs on the high energy - low protein level (HE-LP) was the least efficient.

Protein efficiency was higher for the animals fed the medium energy - low protein level (ME-LP) and was lower for those on the high protein- low energy (HP-LE). Differences between the nine treatments in their average daily gain were statistically significant ($P < 0.05$).

TABLE 1. Average daily gain, feed efficiency and protein efficiency of Rahmani lambs fed different levels of energy and protein during the first 139 days of experimentation.

	High energy			Medium energy			Low energy		
	Daily gain	Feed efficiency	Protein efficiency	Daily gain	Feed efficiency	Protein efficiency	Daily gain	Feed efficiency	Protein efficiency
	g/day			g/day			g/day		
High protein . .	172.08	5.42	0.641	159.71	4.54	0.685	141.75	3.55	0.766
Medium protein	170.71	5.54	0.540	165.46	4.46	0.530	135.75	3.76	0.646
Low protein . .	154.31	5.55	0.487	148.92	4.76	0.462	122.30	4 03	0.516

Feed efficiency calculated as kg Starch Value/kg gain. Protein efficiency, calculated as kg digestible protein/kg gain.

It is clear that increasing energy level from the low to the medium or the high level through each of the protein levels resulted in increasing daily gain and decreasing feed efficiency. Increasing protein level from the low to the medium level through the high energy level resulted in increasing daily gain. Further increase to the high level, however, caused a slight increase in daily gain. Feed efficiency was slightly improved and protein efficiency was decreased with increasing protein level. On medium energy level it was observed that increasing protein level from the low to medium level caused a marked increase in daily gain and feed efficiency However, more increase to the high level resulted in a slight decrease in daily gain and feed efficiency.

On the low energy level, increasing protein level from the low to the medium or the high level resulted in a marked increase in daily gain and feed efficiency.

It is of interest, however, to note that lambs on the ME-MP level gained higher than those on the ME-HP level.

Effect of energy level on gain in weight and feed efficiency

As shown in Table 2 it was observed that daily gain increased, feed efficiency decreased while protein efficiency markedly improved with increasing energy level, during the first 132 exp. period and the entire experimentation.

Analysis of variance indicated that energy level had a highly significant effect on gain weight ($P < 0.01$). Duncan's test showed that this difference was only significant between the low and both medium and high energy level.

It could be concluded that increasiug energy level from the low to the medium level resulted in a significant increase in daily gain. Further shift towards the high energy level resulted in no significant increase in daily gain.

Effect of protein level on gain in weight and feed efficiency

Data shown in Table 3 indicate that daily gain and feed efficiecy were increased while protein efficiency was decreased as the protein level increased.

Analysis of variance showed that protein level had no significant effect on gain in weight. However, Duncan's test showed that there was a significant difference ($P < 0.05$) between the low and both the medium and high protein levels.

In other words, increasing protein level from the low to the medium level caused a significant increase in gain in weight ($P < 0.05$). Further increase to the high level did not increase the body gain during first experimental period, however, a slight decrease in daily gain during the entire experimental period was observed for animals fed high protein rations,

TABLE 2. Average daily gain feed efficiency and protein efficiency of Rahmani lambs fed different energy levels during the first 139 days and during whole experimental period.

Energy level	Number of animals	Daily gain		Feed efficiency kg. S.V/kg gain		Protein Eff. kg DP/kg. gain	
		First 132 days	Whole period	First 132 days	Whole period	First 132 days	Whole period
High energy	18	165.6	140.2	5.50	7.66	0.556	0.698
Medium energy	18	157.9	135.2	4.58	6.28	0.559	0.689
Low energy	18	133.1	102.0	3.75	5.74	0.642	0.884

TABLE 3. Average daily gain, feed efficiency and protein efficiency of Rahmani lambs fed different protein levels during the first 132 days of experimentation.

Protein level	No. of animals	Daily gain g		Average feed efficiency kg SE. / kg gain		Average prot. eff. kg DP/kg gain	
		During 132 exp. period	During whole exp.	During 132 day exp.	During whole ex. per.	132 day ex. period	Whole period
High protein . . .	18	157.6	130.3	4.50	6.26	0.697	0.903
Medium protein . . .	18	157.3	131.2	4.58	6.42	0.572	0.732
Low protein . . .	18	141.8	115.9	4.78	6.92	0.488	0.637

It should be emphasized that increasing energy level through each of the three protein levels resulted in increasing weight gain. However, increasing protein level from the low to the medium level through each of the three energy levels was associated by a marked increase in gain in weight.

It could be observed from all the above results during the two experimental periods that lambs on high energy low protein and those on medium energy low protein gained higher than those on the high protein low energy and those on medium protein low energy level. The interaction between the energy and protein levels failed to be significant under the condition of this study.

Effect of energy and protein levels on the digestability of nutrients and nitrogen balance

Data in Table IV indicate that the highest digestability co-efficient of dry matter was obtained with lambs on the HE-LP. followed by those on the HE-MP and HE-HP levels, respectively. Lower dry matter digestability was obtained by lambs fed LE- LP level.

It could be observed that increasing protein level from the low to the medium level through the high or the medium energy level caused a very slight decrease in dry matter digestability. However, on the low energy level digestability of DM increased markedly with increasing protein level from the low to the medium level. Further increase in protein level caused a slight decrease in DM digestability.

Increasing energy level from the low to the medium and high level through each of the three protein levels resulted in increasing digestability coefficients of DM.

Crude fiber digestability was higher for the group of lambs raised on HE-HP, while it was lowest for these on the LE-LP level. On low energy level, fiber digestability was increased with increasing protein level (Table IV) from the low to the medium. However, on the medium energy level, it was observed that increasing protein level from the low to the medium and high levels resulted in a slight decrease in fiber digestability. On the high energy level, digestability of crude fibers was increased with increasing the protein intake.

On the low protein level increasing energy level from the medium to the high resulted in a decrease in fiber digestability. Also the lowest crude fiber digestability on the medium protein level was reached with the high energy ration. Moreover using high protein ration, digestability of C.F. was decreased with increasing energy level from low to the medium. Further increase to the high energy level resulted in increasing fiber digestability.

Soluble carbohydrate digestability was higher for the group fed HE-LP level and was lower for those on the MP-LE level. Digestability coefficient of NFE was increased with increasing energy intake. However, the level of protein in ration seems to have no marked effect on NFE digestability.

TABLE 4. Average digestability co-efficeint of dry matter, CF, EE and NFE of lambs fed different levels of energy and protein in ration (on dry matter basis)

Energy level	High energy				Medium energy				Low energy			
Prot. level	DM %	CF %	EE %	NFE %	DM %	CF %	EE %	NFE %	DM %	CF %	EE %	NFE %
High protein	68.77	48.09	60.59	80.19	64.51	39.19	64.89	79.90	57.31	44.23	77.76	72.15
Medium protein	69.20	44.09	57.64	81.12	64.12	40.68	60.63	77.01	58.97	36.82	64.65	72.98
Low protein	70.15	40.49	58.78	82.91	65.49	41.24	53.44	78.51	56.53	33.05	64.31	71.64

Ether extract (EE) digestability was markedly increased with the increase of protein intake. However, it was decreased as the energy level increased.

The highest apparent digestability of (N) was recorded for lamb group mentioned on HP-HE ration while it was lowest for those on LP-ME diet followed by LP-LE group (Table 5).

Increasing protein intake from the low to the medium and high level within each of the three energy levels resulted in increasing nitrogn digestability (Table 5).

TABLE 5. Average apparent digestability of nitrogen and average nitrogen balance of lambs fed different levels of energy and protein.

Protein level / Energy level	High protein	Medium protein	Low protein
High energy			
N intake g/day	26.538	22.253	16.377
Fecal N g/day	11.236	10.381	8.555
Urinary N g/day	5.768	2.874	2.446
N digestability %	57.66	53.35	47.76
N balance g/day	+ 9.543	+ 8.998	+ 5.376
Medium energy			
N intake g/day	26.764	21.897	17.241
Fecal N g/day	11.530	10.730	10.264
Urinary N g/day	8.041	3.888	3.161
N digestability %	56.91	50.99	40.46
N balance g/day	+ 7.193	+ 7.279	+ 3.816
Low energy			
N intake g/day	28.102	22.332	16.390
Fecal N g/day	10.874	10.087	9.510
Urinary N g/day	13.066	8.315	4.582
N digestability %	61.300	54.83	41.97
N balance g/day	+ 4.162	+ 3.930	+ 2.290

Higher nitrogen retention was obtained by lambs on HE-HP levels and those raised on HE-MP ration respectively. On the other hand, group of lambs fed on LP-LE diet scorded the lower nitrogen balance. A further fact of note that, lambs fed HE-LP ration showed better nitrogen balance than those on HP-LE ration. However, nitrogen digestability coefficient for the latter group was higher than that for the former one.

Discussion

It has been clearly shown that, the average daily gain of Rahmani lambs ranged from 122.3 to 172.1 g/day during the first 139 days and from 97.88 to 148.44 g/day throughout the entire 236 day-period of experimentation. The corresponding values of feed efficiency were ranging from 3.55 to 5.55 and from 5.52 to 8.0 kg starch/kg gain for the two experimental periods respectively. These results are in good agreement with those obtained by Ghoneim *et al.* (1957), who reported that body weight gain of Rahmani lambs from weaning up to one year old ranged from 0.575 to 0.935 kg/week with an average of 120 g/day. However, feed conversion values ranged from 2.50 to 5.27 kg. SE/kg gain. Saleh (1971) found that average daily gain of the same breed ranged from 65.84 to 120.33 g/day, while feed conversion values ranged from 4.79 to 9.11 kg. SE/kg gain. Saleh's values of daily gain and feed efficiency are lower than those obtained in this study. Such lower value could be attributed to the higher roughage levels in the rations used.

Efficiency of protein utilization ranged from 0.462 to 0.722 and from 0.582 to 1.083 kg. digestable protein per kg. gain for the first 139 days and the whole experimental period (236 days). On Barki lambs raised on 50, 75 or 100% of Morrison standard, Hassan (1970) reported protein efficiency ranging from 0.42 to 0.77 kg digestible protein / kg gain.

As has been noticed it is evident that, on the low energy level, the daily gain increased, feed efficiency markedly improved and protein efficiency decreased as digestible protein intake increased. Similar results were obtained by Allam (1970) and Saleh (1971) with Rahmani lambs even the plant protein was partially replaced by urea. This increase in daily gain could be attributed first, to the inadequacy of the low protein level to growth requirement. Second to the sparing action of excess protein to energy (Lofgreen *et al.* (1951) and Church *et al.* (1966).

Results presented in Table I indicate that lambs on the ME-MP ration gained somewhat higher that those on ME-HP level. Feed efficiency values of the two groups were approximately the same. Protein efficiency was higher for the first group than the second one. These findings agree well with those obtained by Allam (1969) and Allam (1970), who attributed this decrease in daily gain to the higher specific dynamic action of protein than other nutrients. Meanwhile, Blaxter and Martin (1962) concluded that, the low nutritive value of protein as a source of energy is mainly due to its fermentation rather than any percularity in the intermediary metabolism.

Lamb group which fed on ME-MP or that on ME-MP gained higher and were more efficient than those on the ME-LP or HE-LP level. Similar results were obtained by Jones and Hogue (1960), they concluded that lambs on the high energy levels required more protein to maintain their growth rate.

This study revealed that animal on the HE-LP and those on ME-LP gained higher than those on the HP-LE or MP-LE level. Feed conversion was lower and protein efficiency was higher in the first two groups than in the second ones. Such results may explain the importance of the higher energy level in supporting higher body weight gain with low protein rather than high protein levels with low energy. Evidence from the literature explained the way in which the higher energy level in supporting gain in weight. Lofgreen *et al.*, (1951) ; and Broster *et al.*, (1969) ; have shown that on low protein intake, increasing energy supply was associated with increasing nirogen retention and nitrogen utilization. Whiting *et al.* (1959) ; stated that utilization of protein in ruminant depends on the energy content of the ration. Miller (1968), explained the increase in daily gain associated with the decrease in protein intake by the protein utilization. Results obtained in this trial indicate that, nitrogen retention was increased with increasing energy level. Such increase in retained nitrogen occurred through a decrease in urinary nitrogen (Table 5).

On the different protein levels, low, medium or high, it was observed that increasing energy level (low VS medium) resulted in a significant increase in body weight gain. Similar results were obtained by Allam (1970) and Hassan (1970).

Feed efficiency values obtained in this study were highest for the groups of lambs on the low energy level, which are in accordance with the results obtained by Ghoneim *et al.*, (1960) ; Hassan (1970) and Allam (1970) who reported that reduction of energy level in the ration of growing sheep increased feed efficiency. Such reduction in feed efficiency could be attributed to the higher energy losses associated with the increase in energy intake. Blaxter and Graham (1955) showed that loss of energy in feces, urine and heat production per unit feed ingested tended to rise with increasing plane of nutrition. Also Blaxter and Wainman (1961), reported that energy losses in feces tended to increease as feed intake increased.

It is worth noting, that dry matter digestability increased as energy level increased.

With regard to protein level, it would be seen that in the early stage of fattening (up to 8-9 month old), medium protein level was adequate for producing satisfactory gain. The higher protein level did not support more gain in weight. Lambs on the low protein level however, gained significantly lower than those on the medium or the high level. These results are in close agreement with those obtained by Allam (1970).

The results suggest that gain in weight, feed efficiency and protein efficiency decreased as the experimental period prolonged. Such findings could be attributed to the fact that, animals tended to deposit fatty tissues rather than lean tissue.

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تأثير المستويات المختلفة من الطـاقة والبروتين على تسمين الحملان

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تنخفض الكفاءة التحويلية للغذاء كلما زادت نسبة الطاقة الى البروتين فى العليقة . بينما تحسنت الكفاءة التحويلية للغذاء كلما زادت نسبة البروتين الى الطاقة فى العليقة وذلك عن تسمين الحملان الرحمانى ذات عمر ٤ ــ ٥ أشهر وكان متوسط وزنها ٢٢ كيلو جرام .