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Different Levels of Protein and Energy in the Ration for Wool Growth

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FIFTY four 5 months old ram lambs of the Rahmany carpet wool type having a mean live-body weight of 22 kg were given three different levels of protein and energy in a 3×3 factorial design experiment. The levels were high (H), medium (M) and low (L) with nutritive values presented in Table 1. The medium level both in energy and protein (control) was formed according to Morrison (1959) standards. The high level 125% of the control while the low level represented only 75%. The experiment lasted 7 months by the end of which the grease fleece weights were recorded and wool samples were analysed. Highly significant ($P < 0.01$) effect of energy level on clean fleece weight was recorded while the protein level had no significant effect on the same parameter with no interaction between energy and protein. The grease content increased significantly ($P < 0.250$) as the energy level decreased while the suint significantly ($P < 0.250$) decreased by the decrease in energy or protein. However, a small (2.7%) increase in suint occurred when the protein level of the diet decreased from medium to low.

The shrinkage values were affected significantly ($P < 0.250$) by the level of protein in such a way that the higher levels resulted in more shrinkage values while the energy levels did not affect the shrinkage significantly.

Increasing the energy level caused a propotional increase in fiber diameter and the same was noticed when the protein level was increased. No significant effect was noticed on fiber length, or on fiber breaking strength.

It is concluded that an optimum level of protein/energy intake can be determined according to the available materials. Energy and protein may replace each other to get the maximum wool production with best qualities. Low protein/medium energy or vice versa was found to be best for maximum production. But since the other wool qualities are affected by this ratio it was recommended to apply the low protein/medium energy level only to maximum and most sound wool production.

Conflicting results have been reported as to the response of wool growth to protein and energy intakes by sheep. Elsherbiny and El-Ashry (1974) reported an increase in wool growth parallel to the increase in dietary protein of isocaloric rations followed by a decline at higher levels of protein fed to carpet wool sheep. Slen and Whiting (1952) also found the same response with Merino sheep. In contrast, many other authors (Marston, 1948 ; Reis and Schinckel, 1961 ; Reis, 1969 ; Egan, 1970 and Longlands, 1971) have reported that rate of wool growth is influenced by the intake of dietary protein. Reis (1969) suggested that the energy requirements for wool growth are relatively low and that the limiting factor is the available protein and specifically the amino acid. Black, *et al.* (1973) using different protein and energy levels given through the abomasum reported the existence of an optimum relationship between protein and energy intakes at which maximum wool growth would occur. They assumed that it is unilkely that any substantial reduction in wool growth would be produced in nodmally fed sheep by increasing their energy intake when they are given diets low in protein. It seemed therefore sound enough to carry out the present investigation to test the validity of this hpothesis and to find the optimum protein energy ratio for maximum wool production.

Material and Methods

Fifty four ram lambs of Rahmany local carpet-wool type of about 22 kg. mean live-body weightand 5 months old were divided into 9 similar treatment groups, 6 animals each. Three levels of energy and of protein in rations were used in a 3 × 3 factorial design experiment. The levels were high (H), medium (M) and low (L). The medium level for both energy and protein was formed to fulfill the allowances recommended by Morrison (1959) and was considered the control treatment. High level of either energy or protein was formed to cover 125 %of the control, while the low level covered 75 % of the medium level. The different animal groups were randomly assigned to the different nutritional treatments as shown in Table. 1.

TABLE 1. **Energy/protein levels and nutritive ratio of the different lamb groups.**

Lamb group	Animal numbers	Energy/protein levels	Nutritive ratio
1	6	HE/HP	8.5
2	6	ME/MP	8.46
3	6	LE/LP	8.42
4	6	HE/MP	10.5
5	6	HE/LP	11.8
6	6	ME/LP	10.47
7	6	ME/HP	6.6
8	6	LE/HP	4.48
9	6	LE/MP	5.68

The experiment was carried out in the experimental farm of the Faculty of Agriculture, Ain-Shams University till the animals became one year old. At shearing (1 year wool growth) the grease fleece weight were recorded and midright side wool samples were collected, from each animal. The clean fleece weight, the grease content, cold water-soluble extract (suint) and shrinkage estimated and fiber diameter, length and strength were measured. Analysis of variance for each of these parameters was proceeded as suggested by Snedecor (1961) and sequential comparisons between treatment means were tested by Duncan's multiple range test, as described by Snedecor (1961).

Results

Clean fleece weights (Table 2)

No significant differences were detected in clean fleece weights at the three levels of protein, while highly significant ($P < 0.01$) differences were hound between the clean fleece weights of the three energy levels. However, no significant interaction ($P < 0.05$) between energy and protein were found. It is evident from Table 2 that the maximum effect on the mean clean fleece weight was at the medium level of energy regardless of the protein level. As the level of energy decreased from high to medium, a great increase of 52.3% in the clean fleece weight occurred but when the energy level decreasd from medium to low, the result was a dercease of 21.2% in the clean fleece weight. At the low level of energy the clean fleece weight was still 6.7% highelr than that at the higher level of energy. Within the medium level of energy an increase in clean fleece weight occurred parallel to the decrease in protein level being 22.6% from HP to MP and 7.5.% from MP to LP, but from PH to LP the increase in clean fleece weight was only 21.5%.

TABLE 2. **Mean clean fleece weights in kg.**

	H.P.	M.P.	L.P.	$\overline{X}$
H.E.	1.787 ± 0.219	1.815 ± 0.082	1.462 ± 0.133	1.681 ± 0.92
ME.	2.062 ± 0.115	2.330 ± 0.172	2.506 ± 0.143	2.299 ± 0.078
L.E.	1.871 ± 0.214	1.706 ± 0.111	1.834 ± 0.185	1.810 ± 0.102
$\overline{X}$	1.899 — 0.105	1.951 ± 0.099	1.094 — 0.139	1.917

Concerning the grease content, no significant (P< 0.05) differences were found between the three protein levels nor the three energy levels, neither was there any significant (P 0.05) interaction between protein and energy groups. Testing the significance at a level of 0.250, it was found that only the differences between the three energy levels which were significant. As the energy levels decreased from high to medium, medium to low and from high to low, the grease percentage increased by 0.5%, 11.5% and 12.1% respectively. The differences were only significant from medium to low and from high to low.

TABLE 3. **Mean grease content in percentage.**

H	HP	MP	LP	$\bar{X}$
HE.	3.62%	3.40%	4.19%	4.50%
ME	4.14%	3.67%	4.40%	4.07%
LE.	4.06%	4.69%	4.69%	4.54%
$\bar{X}$	4.22%	3.92%	3.49%	4.52%

Cold water-soluble extract suint (Table 4)

Significant (P<0.250) differences were found between the nine treatment groups due to differences in both protein and energy levels and their interaction. The decrease in the level of dietary protein from high to medium and from high to low resulted in a 12.9% and 10.5% decrease in the cold water-soluble

TABLE 4. **Mean cold water-soluble extract (suint) percentage.**

	HP.	MP.	L.P.	$\bar{X}$
H.E.	39.18%	27.89%	32.24%	33.41%
M.E.	32.65%	31.58%	24.43%	29.55%
L.P.	29.07%	28.49%	33.30%	30.21%
$\bar{X}$	33.69%	29.32%	30.13%	31.14%

extract, while from medium to low an increase of 2.7% occurred. The same trend was observed by changing the level of energy from high to medium to low irrespective of protein level. The highest value of C.W.S.E. was that in treatment No. 1 39.18% with high energy and high protein levels. At the high protein level a consequent decrease in C.W.S.E. was noticed as the energy level was changed from high 39.18% to medium 32.65% to low 29.07%. This trend was not observed elsewhere except within the medium level of energy where the C.W.S.E. decreased by the change in the protein level from high to medium to low from 32.65% to 31.58W to 24.43% respectively.

Shrinkage (Table 5)

The differences between the protein levels and the interaction between the protein and energy levels were significant ($P < 0.250$). The differences due to energy were not significant at the same level of probability.

It seems however, that within the high protein level, the shrinkage increased as the energy levels increased from low to medium to high, being 33.14%, 36.78% and 43.64% respectively. The high shrinkage value 36.91% was that for the high protein groups regardless of the energy level. The low levels of protein caused also higher shrinkage values as compared to medium levels although these values were still less than those for the high protein group. The froup recieving low protein low energy shrinked 38.26% which was greater than the low protein high energy group 36.43% or the low protein medium energy group 28.83%.

TABLE 5. **Mean shrinkage percentage.**

	H.P.	M.P.	L.P.	$\overline{X}$
H.E.	31.57%	31.48%	28.65%	30.57%
M.E.	37.9 %	41.57%	48.19%	42.57%
L.E.	40.45%	36.64%	41.18%	39.42%
$\overline{X}$	36.66%	36.56%	39.34%	37.52%

Fiber diameter (Table 6)

Significant ($P < 0.250$) in fiber diameter were found between the different protein and energy treatments with no significant interaction having been detected. The effect of energy was such that the increase in its level from low to medium to high caused a proportional increase in the mean fiber diameter regardless of the protein level. This trend was almost the same within the low and medium levels of protein at the different energy levels. Within the high protein level, the fiber diameter increased only when the energy was increased from low 32.48 ± 0.65 μ to medium 35.22 ± 1.27 μ but decreased again to 32.46 ± 0.81 μ when the energy reached the high level. This trend was the same general trend observed at the different levels of protein regardless of the energy levels.

TABLE 6. **Mean fiber diameter in microns.**

	H.P.	M.P.	L.P.	$\overline{X}$
H.E.	32.46 ± 0.818	38.92 ± 1.677	36.62 ± 0.431	36.04 ± 0.872
M.E.	35.22 ± 1.271	35.12 ± 3.440	33.17 ± 2.270	34.56 ± 1.417
L.E.	32.48 ± 0.654	34.20 ± 1.573	32.50 ± 2.190	32.98 ± .891
$\overline{X}$	33.33 ± 0.632	36.30 ± 1.354	34.46 ± 2.190	34.52

Fiber length (Table 7)

No significant differences were found between the protein or energy levels with respect to fiber length. The highest overall mean fiber length was that recorded for the medium level of energy regardless of the level of protein. The LP /ME. and the LE /MP treatments attained the largest means of fiber length being 11.85 ± 1.01 and 11.28 ± 0.41 cm respectively.

TABLE 7. **Mean fiber length in cm.**

	H.P.	M.P.	L.P.	$\overline{X}$
H.E.	9.55 ± 0.32	10.68 ± 1.12	10.35 ± 1.13	10.21 ± 0.39
MP.	10.54 ± 0.42	10.50 ± 0.30	11.85 ± 1.01	10.93 ± 0.37
L.E.	9.97 ± 0.55	11.28 ± 0.42	9.41 ± 0.96	10.18 ± 0.40
$\overline{X}$	10.02 ± 0.33	10.81 ± 0.31	10.51 ± 0.56	10.46

Fiber breaking strength (Table 8)

No significant differences ($P < 0.05$) were found between the protein or the energy treatments nor was there any interaction between the two, to affect the breaking strength. However, it was clear that regardless of the protein level, the mean fiber breaking strength tended to increase by increasing the enegry level from low (9.430 ± 76 g/fiber) to medium (9.66 ± 1.10 g/fiber) to high (9.98 ± 0.61 g/fiber). The highest breaking strength value (12.03 ± 2.29 gm/fiber) was that attained in the MP/ME group followed by the LP/HE (10.30 ± 0.83 g/fiber) group. The least breaking strength value (7.11 ± 1.65 g/fiber) was that for the LP/LE group.

TABLE 8. Mean fiber breaking strength g/fiber.

	H.P.	M.P.	L.P.	$\bar{X}$
H.E.	0.78 ± 1.404	9.87 ± 1.131	10.30 ± 0.834	4.98 ± 0.614
M.E.	8.67 ± 1.586	12.03 ± 2.287	7.70 ± 0.762	9.66 ± 1.101
L.E.	9.56 ± 1.293	7.36 ± 0.962	7.11 ± 1.651	9.43 ± 0.758
$\bar{X}$	9.40 ± 0.765	9.75 ± 0.993	8.52 ± 0.716	9.26

Discussion

Clean fleece weights

The results have shown that the clean fleece weight was increased when the enegy level decreased from high to medium or when the energy level icreased from low to medium, therefore the medium level of energy proved to be the optimum to produce the maximum clean fleece weight regardless of the level of protein. But although there was no interaction between the energy and protein, yet the maximum clean fleece weight (2.506 ± 0.143 kg) was obtained in the ME/LP group. It may be focused in this respect that there is an optimum energy/protein ratio at which the animal is capable to produce the maximum wool. In the present study it apperas that the nutritive ratio 1 : 10.47 (ME/LP) was the optimum which produced the maximum clean wool.

Since the level of protein did not have a significant effect on clean fleece weight, and the effect was highly significant for the level of energy. It was postulated that in a ration containing different levels of protein and energy, the predominating factor to affect the clean fleece weight is energy, while the protein is of secondary importance and in this case also the least amount of protein would be enough to maintain the maximum production. This result is in accordance with that of Egan (1970) and Black, (1973) who stated that an increase in rumen fermentation caused by increasing the energy level of the low protein diet would increase microbial protein production and also the amount of protein reaching the intestines. A decline in mean clean fleece weight, although not significant, was observed in the present experiment when higher or lower than medium levels of protein were provided. Munoro (1957) has shown that carbohydrate is needed in order that amino aclas can be utilized, and that unless carbohydrate is fed at the same time as protein, the protein is not so readily utilized and nitrogen excretion increase. In absence of carbohydrate is necessary for mitosis to take place. Therefore, absence of carbohydrates or its presence in lower levels would perharps lead to such wool growth reduction.

Grease, suint and shrinkage

The energy level had a significant ($P < 0.250$) effect on the grease content and the trend was such that the increase in energy intake caused a proportional decrease in the mean grease percentage regardless of the protein level. Within the low and medium levels of protein the same trend was observed by increasing the level of energy. On the other hand, both energy and protein levels had a significant ($P < 0.250$) effect on the suint content of the fleece and their significant interaction showed that the HP/HE group had the highest content of suint while the lowest content was in the LP/ME group. It appears however, that the higher levels of energy causes a decrease in grease content and an increase in suint, and while then protein level of the ration had no significant effect on the grease content, it showed a significant effect on the suint percentage. The combined effect however, is shown in the shrinkage)percentage where the largest shrinkage value was recorded for the group recieving HE/HP ration and the lowest was for the group recieving ME/LP ration parallel to the percentage of suint, which means that the suint but not the geaseis the main factor which causes increase or decrease in the shrinkage and that both the protein and energy levels of the diet would affect this percentage. This result seems to be sound since the higher levels of energy and protein encourage the metabolism a result of which is the increase in suint percentage causing the corresponding increases in shrinkage values. This result confirms that previously reported by Elsherbiny and El-Ashry (1974) who found that the highest grease plus sweat percentages were recorded for groups of Rahmany lambs maintained on high nitrogen rations.

Fiber diameter

Significant ($P < 0.250$) differences in fiber diameter were found due to different levels of energy and protein and the trend was that the increase in energy from low to medium to high caused a consequent increase in the mean fiber diameter regardless of the protein level which is in accordance with the results reported by Black, *et al.* (1973) who reported an increase in wool growth rate in response to higher levels of energy although it was not known whether the response was in fiber diameter or length. On the other hand the medium protein group attained the largest fiber diameter but decreased in the high and low protein groups although the decrease was less pronounced in the low protein group. This result confirms those previously reported by Slen and Whiting (1952), Ferguson (1962) and Elsherbiny and El-Ashry (1974) who reported an increase in fiber diameter at first in response to protein supplementation of the diet followed by a substantial decrease when the protein content of the diet reached a high level. It seems however, that both the protein and energy levels act independently on fiber diameter, for while the diameter, continued to increase by increasing the level of energy it tended to increase at first by increasing the protein till the medium level then decreased again by the rise in protein to the high level. This is in accordance with the findings of Egan (1970) and Black, *et al.,* (1973) which explained the effect of energy on encouraging the retention of microbial protein at low levels of dietary protein. Although no significant effects on fiber length were found due to either energy or protein levels of the diet, yet the trend was that the maximum mean length was that obtained in the medium energy group regardless of the protein level and for the medium protein group regardless of the energy level. The group maintained on ME/LP (nutritive ratio 1 : 10.47) and that maintained on MP/LE (nutritive ratio 1 : 5.68) had the largest fiber length which leads to the postulation that the protein and energy may replace each other to a limited extent to produce the maximum wool eigth. This may be explained on basis that for optimum wool growth there should be a certain level of protein available for fiber substrate, but for the synthesis of such protein a certain level of energy should be available to enhance the incorporation of amion acids in gluconeogenesis (Black, *et al.* 1973).

Fiber breaking strength.

Although no significant effect for either the protein or the energy levels was observed, yet the trend was an increase in the rensile strength corresponding to the rise in the level of energy. This trend follows that of the fiber diameter since the strength is highly correlated to fiber diameter. This result, though not signifcant may reveal that the breaking strength of wool fiber is more dependent on the energy intake rather than the protein intake. A combination of medium energy and medium protein (nutritive ratio 1 : 8.46) is best suited to produce strong wool fibers termed in textile as sound wool.

In conclusion, an optimum level of protein energy intake can be determined according to the available materials. Energy and protein may replace each other to get the maximum wool production with best qualities. Low protein/medium energy or *vise versa* was found to be best for maximum production. But since the other woll qualities are affected by this ratio, it is best recommended to apply the low protein/medium energy (nutritive ratio 1 : -0,47) only to get the maximum and most sound wool production.

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تأثير مستويات مختلفة من البروتين والكربوئيدرات على نمو الصوف فى حملان الرحمانى

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اختيرت مجموعة من حملان الرحمانى قوامها ٥٤ حمل فى عمر خمسة أشهر ومتوسط وزنها ٢٢ كجم وقسمت الى تسع مجموعات متساوية حيث غذيت المجاميع على ثلاث مستويات مختلفة من كل من البروتين والكربوئيدرات . وكانت المستويات عالية ومتوسطة ومنخفضة ممثلة فى جدول رقم ١ .

فالمجموعة المتوسطة فى البروتين والكربوئيدرات (المجموعة المقارنة)وضعت مستوياتها الغذائية تبعا لمعدلات Morrison سنة ١٩٥٩ بينما المجموعة ذات المستوى العالى كانت ١٢٥٪ من المجموعة المقارنة . أماالمجموعةذات المستوى المنخفض فتمثلت فى ٧٥٪ فقط من المستوى الغذائى للمجموعة المقارنة . وقد استمرت التجربة لمدة ٧ أشهر قدرت فى نهايتها أوزانالجزات الخام كما تم جمع عينات من الصوف للتحليل . ولقد اتضح أن هناكتأثير عالى المعنوية $P \leq 0.01$ لمستوى الطاقة على وزن الجزة النظيفة بينما لم يؤثر مستوى البروتين تأثيرا معنويا عليها كما لم يكن هناك تأثير تفاعلى معنوى بين كل من الطاقة والبروتين على وزن الجزة النظيفة . وقد زادت نسبة المواد الشمعية فى الصوف زيادة معنوية عندما انخفض مستوى الطاقة فى الغذاء بينما أدى انخفاض أى من مستوى الطاقة أو البروتين الى انخفاض فى محتوى الصوف من المواد العرقية ولو أن زيادة طفيفة فى نسبة المواد العرقية (٢ر٧٪) قد نتجت عندما انخفض مستوى البروتين فى الغذاء من المستوى المتوسط الى المستوى المنخفض .

وقد أدى ارتفاع مستوى البروتين فى الغذاء الى ارتفاع نسبة الفقد فى الصوف عند غسيله بينما لم يؤثر مستوى الطاقة تأثيرا معنويا على نسبة الفقد .

زيادة مستوى الطاقة أدى الى زيادة متوازية فى قطر الألياف وقد حدث نفس التأثير عند زيادة مستوى البروتين . بينما لم يتأثر طول الألياف بتغير مستوى الطاقة أو البروتين . كما لم يحدث أى تأثير على القوة اللازمة لقطع الالياف . وعلى ذلك يمكن القول أن هناك مستوى أمثل للبروتين والطاقة فى علائق الأغنام لانتاج الصوف وهذا المستوى يمكن تقديره تبعا للمواد الغذائية المتوفرة فيمكن أن تقوم الطاقة مقام نسبة من البروتين كما يمكن أن يحل البروتين محل نسبة من الطاقة فى علائق الاغنام وذلك لاحداث أقصى انتاج للصوف كمية ونوعا . وقد اتضح أن نسبة منخفضة منالبروتين مع نسبة متوسطة من الكربوئيدراتأوالعكس نسبة منخفضة منالكربوئيدرات مع نسبة متوسطة من البروتين كانت أنسب المستويات الغذائية للحصول على أقصى انتاج . ولكن نظرا لتأثر الخواص الأخرى الطبيعية لأليافالصوف الناتجة عن هذه النسب فمن المستحسن أن يتبع المستوى المنخفض من البروتين والعالى فى الطاقة فقط لانتاج أقصى وأجود انتاج من الصوف .